THE FUTURE OF MEDICINE

DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. X. No. 118. OCTOBER, 1929. PRICE 1s. NET

SOLVING THE SECRETS OF HEREDITY
(See page 340)

CHIEF CONTENTS.

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Edited by John A. Benn.

Publishers: Benn Brothers, Ltd. All communications respecting editorial matters to be addressed to the Editor; all questions of advertisements and subscriptions to the Manager.

Offices: Bouverie House, Fleet Street, London, E.C.4. (Closed on Saturdays.)

Telephone: City 0244 (10 lines).

Telegrams: Benbrolish Fleet.

Annual Subscription, 12*s*. 6*d*. post free anywhere in the world. Single numbers, 1*s*. net; single back numbers more than two years old, 1*s*. 6*d*. net: postage 2*d*.

Binding cases, price 2*s*. 6*d*. net each; postage 6*d*. Complete bound volumes, 17*s*. 6*d*. net each; postage 1*s*.

Editorial Notes.

Those who heard by wireless the landing of the Graf Zeppelin after its flight round the world, or who listened to the record speeds announced from Southampton during the Schneider Race, cannot have failed to experience a thrill at these latest conquests of time and distance. Yet if, as we did, they happened soon after to turn the pages of a new book on astronomy written by Sir James Jeans,* they may have shared the reflection that perhaps these achievements were not so remarkable after all. When the first flying machines just managed to leave the ground and to glide above the tree-tops, it was by no means generally foreseen that some twenty years later men would travel through the air at 355 miles per hour. But the more optimistic did realize that great speed would be the logical outcome of flying at all, though it was not then known that the limit would so soon be reached. The more cautious students of aviation are now recognizing that there is a maximum speed, perhaps even now within sight of attainment, beyond which mechanical laws will not allow us to go. With regard to astronomy, on the other hand, not even Galileo can have had any conception of where his telescope would lead, and the experts of to-day are more cautious in their predictions than ever before. Three hundred years of watching the heavens and all the perfection of modern instruments only confirm the conclusion that the universe contains more secrets than are ever likely to be solved. One of these secrets, the mystery of motion, is discussed elsewhere in this issue by a Canadian contributor.

* * * * *

Sir James Jeans gives an arresting picture of the birth of astronomy. Surely no book has ever bridged the centuries more adroitly, or put the reader so completely in the shoes of the men who first looked through telescopes. Following the admirable practice of modern historians, Sir James writes in the present tense. "And now Galileo catches Jupiter in the field of his telescope and sees four small bodies circling around the great mass of the planet—like moths round a candle-flame." The pioneer is seeing an exact replica of the solar system as imagined by Copernicus, but yet, like ourselves to-day with any new experience, "he hardly sees the full implications of his discovery at once; he merely avers that he has discovered four new planets which chase one another round and round the known planet Jupiter." No wonder that the instrument created a sensation in 1608, when it was exhibited to the Doge of Venice. And so vividly is the story told again, that even in 1929 we envy those aged Senators who climbed the highest towers of their city to spy at ships, too far away to be seen with the naked eye.

* * * * *

As for the future of astronomy and its importance at the present time, Sir James Jeans admits that science cannot yet say anything final on the questions of human destiny. But this is no justification for our not becoming acquainted with the best that science has to offer. Fortunately for our successors, guessing is now discouraged, in face of more facts than were ever before at our disposal. From the utilitarian standpoint astronomy is essential to the study of physics and chemistry, and each star is now regarded as an experiment on the heroic scale. The matter available for study on earth comprises only one part in a million million of the whole range known to nature. But it is the aesthetic aspect of astronomy which makes the widest appeal. Sir James compares its revelations of the universe to a jig-saw puzzle. All

**The Universe Around Us.* (Cambridge University Press.)

the pieces would doubtless form a consistent picture, but it may be beyond the human intellect to find the missing fragments. By comparison with the more comforting attitude of another writer in this field, Professor A. S. Eddington, some of Sir James Jeans' other speculations may leave our minds in chaos. But that, we suppose, is inevitable, when we enter the rarified atmosphere of the outer universe.

* * * * *

At the moment of going to press, some further details of the British Association meeting have been received from South Africa, supplementing the report which we print on another page. The work of Miss Caton Thompson alone assured a meeting of exceptional importance for the anthropologists, yet hardly less than the interest in Zimbabwe, was the anticipation of hearing Mr. Leakey's report on his two years' search for traces of early man in East Africa, especially in view of the light which this, possibly now and certainly later, might throw on the same problem in South Africa. As the sub-continent forms a *cul de sac* into which a succession of human types and cultures had been forced wave on wave, it is within the bounds of reasonable probability that in the more favourable conditions of the Rift Valley of Kenya, excavators may be able to afford a glimpse of South African man at an early phase of his evolution, while making his way southward.

* * * * *

Early in July, but unfortunately after most members of the British Association had sailed, Mr. Leakey and Mr. Solomon had announced in a letter published in *Nature* that the results of their work in 1928-29 called for a modification of their earlier views, reported at the Leeds meeting in 1927 (see *Discovery*, VIII, 329). From Mr. Leakey's new report presented at Johannesburg, it would now appear that instead of three pluvial periods, there were really four distinct periods of heavy rainfall in East Africa, though the first two were separated by a brief period of aridity only. With each era of prehistoric time, when divided up according to these pluvial periods, was associated a characteristic stone age culture. The implements presented certain very striking resemblances to the European stone age cultures, but also certain marked differences, to be attributed to local conditions and localized development. Thus in the first pluvial or Ebburrian phase occurred the Acheulean type; in the second or Enderian phase, the Lower Kenyan Mousterian and Lower Kenyan Aurignacian; and in the third pluvial or Gamblian phase, the Upper Kenyan Mousterian and Upper Kenyan Aurignacian. The parallel occurrence of Mousterian and Aurignacian types in the second and third pluvials is to be noted, this being in contradistinction to conditions in Europe where Aurignacian succeeds Mousterian. It is only very late in the third phase that the two cultures become fused. In the fourth pluvial or Makalian phase, the Elmenteitan occurs, a culture which is a localized development from the Upper Kenyan without exact parallel in Europe but having affinities with Magdalenian. Finally in a post pluvial phase, the Nakurian, is a culture resembling the Wilton industry of Rhodesia. During the excavations, Mr. Leakey found human skeletal remains of Gamblian and also Elmenteita dates, both unquestionably *homo sapiens* and equally certainly non-negroid. A number of bones of animals, some extinct, were also discovered, but have not yet been worked out. It is too early to arrive at any final conclusion as regards dating, but it is suggested that in the four pluvials we have four periods of intense rainfall, coinciding with periods of glaciation or Ice Ages further to the north in Europe.

* * * * *

Following our recent note on tung oil, an essential ingredient in varnish manufacture, we have received an interesting letter on the subject from a reader in China. We pointed out that the nut from which this oil is obtained had until recently been grown only in that country, but is now being planted experimentally in various parts of the British Empire. Seeds have been distributed from Kew to many research stations overseas. Mr. Edward Little, of Peitaiho, tells us that he took with him from North China a quantity of the seeds to New Zealand, and there planted them on his property at Kerikeri, in the Bay of Islands. They are already growing with promise, but as the tree takes five years to bear fruit, we must wait awhile to hear whether this initial experiment has succeeded.

* * * * *

In the article by Mr. E. N. Fallaize published in our September issue, under the title "Why Britain Needs a Race Survey," a sentence was omitted in printing the opening paragraph, which would have made it clear that the second paragraph was intended to refer not to conditions during the war, but dealt with the situation in and following on 1904. "This lack of detailed information," the missing sentence ran, "had already been stressed in the evidence given before the Inter-Departmental Committee on Physical Deterioration which was appointed in 1904, and it was largely as an outcome of the Commission's Report that after some considerable agitation the medical inspection of school children was imposed as a duty upon education authorities in 1907."

The Mystery of Motion.

By A. Vibert Douglas, Ph.D.

Macdonald Physics Laboratory, McGill University, Montreal.

After discussing the various kinds of motion observed in the universe, the author asks whether astronomers have reached the climax in their survey of the motion of heavenly bodies. Interesting possibilities arise.

"NEVERTHELESS it moves"—Galileo, the aged thinker, bowed down in body and weary in spirit before his inquisitors, may not have spoken these words of stubborn defiance, but there is no doubt whatever that they represent the secret thought of that mighty intellect, in spite of the outward recantation forced from his lips in that tragic hour. Gone was the static earth of early eastern thought, gone was the geocentricism of the Chaldeans and of the majority of the Greek thinkers. Aristarchus of Samos had speculated more wisely than he knew, and the cautious Copernicus had set forth with compelling logic the theory of a rotating and revolving planet.

Still Unsolved.

The mystery of motion ! This substantial earth, this *terra firma* beneath our feet, is not the motionless centre of the universe, but is a spinning, wobbling, curving, swerving, ever moving speck of stellar substance tracing out some exquisitely intricate path in the immensities of space. Three centuries have rolled by and still there are wise men striving to unfold the mystery of the true motion of the earth. Much has been learned but, like the evening mist in the Tyrolean mountains which dissolves away as you approach only to close in again with elusive, rosy fingers beckoning you towards the next defile, so this mystery of motion leads the astronomer on and on towards the hope of full understanding only to baffle him again with vague suggestions of motions on a still vaster scale—motions and yet other motions superimposed on the motions of which he has certain knowledge.

Let us try to visualize the path in space followed by a point on the earth's surface. You, reader, may be the point, and perhaps you are situated near Lat. 51° N., Long. 0°. If the earth had no motion except its spin, the diurnal rotation on its axis which gives the succession of night and day, then you would describe a succession of perfect, coincident circles. Wearying of this monotony, you might wander about a little, walk along the street, cycle about a quiet countryside, motor to a neighbouring town and back—then your path or locus would no longer be a perfect circle but would show minute irregularities, small deviations from the smooth line, loops, cusps, curves, and microscopic zigzags. If, venturing further afield, you travelled towards the equator, your locus would become an expanding spiral. If you approached the poles, the spiral would grow smaller and smaller until at either pole your locus would shrink to a point.

But conditions are not so simple. The axis of the earth is not fixed in direction, but is wobbling like that of a slowly spinning top. Thus, instead of a succession of perfectly coincident circles we have each successive one tilted slightly relative to the previous one, and thus we picture a distorted closed spiral, bent, flattened, warped. This wobble is known as Precession, and is caused by the gravitational pull of the moon and the sun on the earth's equatorial protuberance. One complete wobble takes place in about 25,800 years, so that this effect upon the locus is barely perceptible from day to day, yet cumulatively it is very great. A further complication is introduced by the fact that this wobble is itself uneven, being now greater, now lesser according to the relative positions of moon and sun with reference to the plane of the earth's equator. The sinuosity thus imposed upon the precessional wobble is known as Nutation.

Thus, due to spin and wobble alone, a dweller at the equator is being carried through space at a speed of about 29 miles per second, while he who lives in Lat. 51° is borne around his spiral path at about 18 miles per second.

Orbital Motion.

As John Kepler discovered in the seventeenth century, the earth's orbit about the sun is an ellipse. In a little more than 365 days the earth makes its complete journey of something like 580 million miles around this orbit. Apart altogether, then, from spin and wobble, every point on the earth is being rushed through space around and around the sun at the rate of about 19 miles per second. The speed is greatest when the earth is in the part of its orbit nearest the sun, and decreases somewhat when at apogee or

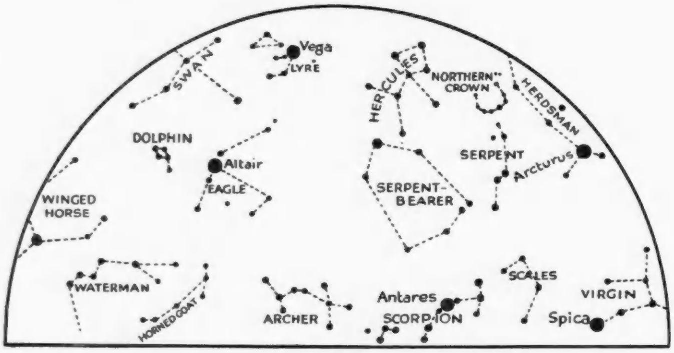


FIG. 1.
THE HEAVENS FROM LATITUDE 50° N.
Brightest stars in region of greatest star density, where the centre of our galaxy is believed to lie.

greatest distance from the sun. Endeavour now to combine these motions: the daily rotation, the long period wobble, and the yearly revolution. Truly it is a fantastic and beautiful locus that is being traced out by each of us as the hour-glass measures the passage of time.

It was the inspired researches of that rare genius Sir William Herschel that first gave mankind the vision of a yet vaster motion which we were undergoing together with the sun, the moon, and all the planets and satellites of the Solar System. Close observation of the stars had revealed the fact that they are not "fixed" but freely moving bodies, and that it was quite possible to measure the changes in their relative positions from year to year, from decade to decade. The motions of many thousands of stars are now known with considerable accuracy, but in Herschel's day there were only seven stars whose motions were accurately measured. Yet with a boldness and a daring typical of his genius, Herschel set out to deduce from these seven observations the motion of the sun through space. Since he knew no reason why the stars should be moving in any particular direction he assumed that the mean velocity of any random group of stars, taking account both of the magnitude and of the direction of the motion of each, would be zero; and that if it were not zero then the resultant mean velocity was really an apparent effect due to the motion of the Solar System in the reverse direction. In this way he arrived at the conclusion that the sun is moving with a velocity of about 12 miles per second towards a point which lies in the constellation of Hercules between the bright, well-known stars Arcturus and Vega. This point towards which the entire Solar System is drifting is referred to as the Apex of the Sun's Way. All subsequent analysis of the vast accumulation of recent data as to the motions of the stars and star clusters, has confirmed in a very striking way this earliest determination of Herschel's, locating the Apex in the same region of the sky and finding the velocity of the sun to be of the same order of magnitude—approximately 12 miles per second.

Small but none the less important differences in the various determinations of Solar Motion and Apex, as determined from specially selected groups of stars (as, for example, the B stars, very bluish and mostly very distant; the Orion stars; the stars of the Pleiades group; the Ursa Major stars; the globular clusters), have proved that the assumption of random motion requires some modification. Just as each planet and satellite has its own peculiar motion as an individual, but partakes of the general motion of the solar system as a whole, so each star may have its random peculiar motion and yet certain groups of stars may have a group motion as well. Thus there are recognized clusters of stars, the members of which have a common space velocity; and when many stars scattered throughout many parts of the sky are found to have a kindred motion, this is referred to as "star streaming."

Two major star streams are well recognized, and various theories have been proposed in an effort to explain their motions. Is this vast assemblage of ten thousand million stars to be compared to two intermingling swarms of bees? Or is it really just one swarm, of ellipsoidal as opposed to spherical shape? All the stars of this assemblage, or let us call it the galaxy, are inevitably subjected to the gravitational attraction exerted from the mass-centre of the galaxy. Where is this centre? Are the stars perhaps revolving about it in elliptic orbits? As one cosmologist, Dr. L. Silberstein, has suggested, perhaps the galaxy is unstable and many of the stars, following hyperbolic orbits, will recede farther and farther from the centre of the galaxy and eventually escape entirely, passing out into intergalactic space.

One question which has very naturally arisen in the minds of astronomers is this—If we could view this galaxy from far out beyond the limits of the Milky Way, what would it look like? Would it perhaps look like a spiral nebula? Modern astronomy has discovered many thousands of these nebulae and found them to be each a galaxy of many million stars. In each of these there appears to be a central mucleus where the stars are less isolated from one another, and outside this the stars are grouped along

great outward sweeping arms and the main or preponderating movement of the individual stars is outward along the arms. If, instead of viewing one of these vast spirals from without, you viewed it from the vantage point of some star fairly near the nucleus, how would it appear? Would it present the appearance with which we are familiar in our own galaxy as seen from near the sun—a strongly marked, though somewhat irregular, galactic concentration or Milky Way, globular clusters, open clusters, star clouds, and the phenomena of star streaming? It is quite plausible, indeed it is almost certain, that these are just the characteristics that would be observed, and therefore it is at least a justifiable guess that the great aggregation of stars in which our sun has his place is in reality a spiral nebula. Assuming tentatively that this is the case, the astronomer seeks to interpret the known facts of the distribution and movements of the stars in the light of this hypothesis. First then let him discover, if he can, where is the nucleus, the centre of the galaxy.

Several regions of the sky have been proposed in this connexion, but the most favoured position has been in that richly star strewn portion of the Milky Way which lies in the constellation of Sagittarius. Quite recently at Harvard Observatory a systematic search for the region of greatest star density has confirmed the belief that the centre of the galaxy lies in the direction of the great star clouds in Sagittarius.

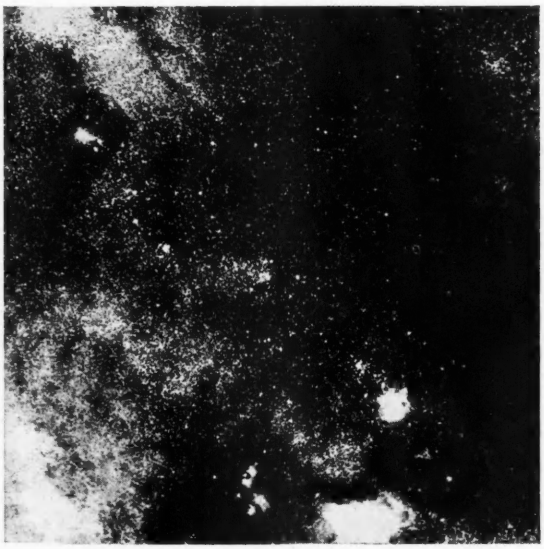


Fig. 2.
SAGITTARIUS.
Photograph of a region in Sagittarius north of the Great Star Cloud, from a 4 hour exposure by Barnard.

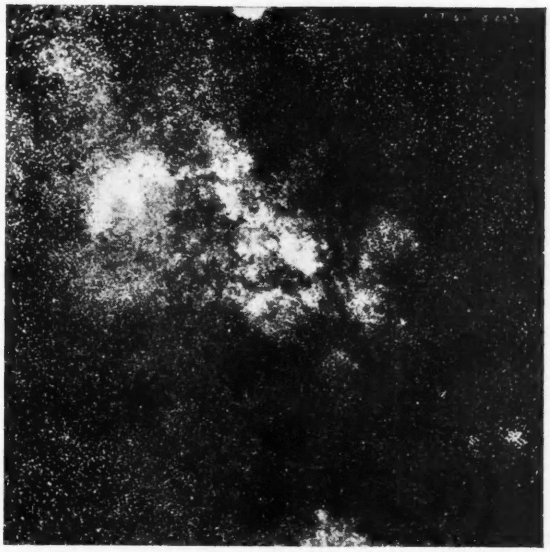


Fig. 3.
STAR CLOUDS IN SAGITTARIUS.
The Great Star Clouds in Sagittarius, from a 3 h. 58 m. exposure by Barnard.

Fig. 1 shows a portion of the heavens as they appear from about Lat. 50° N. looking south on an August evening. The zodiacal constellations Virgo, Libra, Scorpio, Sagittarius, Capricornus, and Aquarius lie low in the sky. The Milky Way comes down through the constellations Cygnus (Swan), Aquila (Eagle), Sagittarius (Archer), and portions of Ophinchus (Serpent-bearer) and Scorpio. Fig. 2 is from a four hour exposure by the late Professor E. E. Barnard of the upper western part of Sagittarius just below Aquila. It shows in striking manner the contrast between these bright portions of the Milky Way with their myriad stars and the darker regions to the westward where obscuring nebulosity—perhaps it is cool gaseous matter, perhaps it is meteoric dust—pervades interstellar space in this direction and almost completely cuts off our view of the stars behind it.

The great star clouds of Sagittarius are beautifully shown in Fig. 3, and the dark nebulosities of the adjacent constellation, Ophinchus, just to the westward, also present a remarkable appearance. Star counts indicate that as the dark nebulosity shown in the lower right of Fig. 3 is approached from every side, the number of stars is increased. The conclusion of Shapley is that if the obscuring curtain were not there the region of maximum star density, the nucleus or centre of our galaxy, would be revealed. Rich star clouds lie to the west, and a beautiful

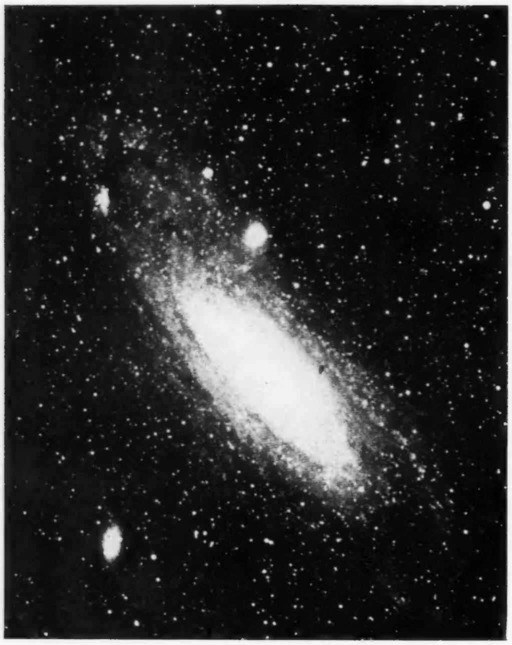


FIG. 4.
THE GREAT NEBULA IN ANDROMEDA.
A spiral aggregation of a thousand million stars far out beyond the Milky Way, distant a million light years from the solar system. (From a Yerkes Observatory photograph.)

star cluster is situated near by. Behind this cluster and extending most densely to the north of it, is this vast, mysterious, enshrouding nebulosity completely hiding from our view the centre of the galaxy which is believed to be at a distance of some 47,000 light years in the direction of the background just above the cluster in this photograph.

Spectroscopic observations of the nearest spiral nebula, the Great Nebula in Andromeda (Fig. 4), has revealed the fact that it is in rotation about its centre, its period being of the order of seventeen million years. Is our great galaxy likewise in rotation? The distinguished Dutch astronomer, Oort, believes this to be the case, and he has calculated to what extent such rotation would affect the apparent motions of the stars as measured from the earth in different directions. Similar speculations have been made by two other astronomers, Lindblad and Schilt, while the first observational confirmation was announced by J. S. Plaskett of the Dominion Astrophysical Observatory in 1928. Quite recently Plaskett has produced more weighty evidence for the reality of this rotation, his study of the motions of some 800 very distant stars leading him to the conclusion that they are revolving about the central nucleus of the galaxy in a period of approximately one hundred million years.

Further confirmation of this vast galactic motion is afforded by a remarkable investigation recently concluded by O. Struve. He has studied the spectroscopic evidence for the presence of calcium atoms throughout the galaxy. Eddington had calculated a density of 10^{-24}, equivalent to about one atom per cubic centimetre, for this calcium substratum filling interstellar space. Struve's observational data points to a lesser density, 10^{-26} or one atom per 100 c.c. He has pointed out that this means that one per cent of all the matter in the galaxy is evenly spread out as a gaseous substratum, while ninety-nine per cent is condensed into stars and dense nebulae. But the relevant point in this connexion is that this widely disseminated calcium is found to partake in the galactic motion of rotation.

Have we now reached the climax in our survey of the motions of the heavenly bodies? We have noted the spin and wobble of our planet as it moves round and round the sun, which is itself speeding away towards the Hercules stars and simultaneously being carried around a vast orbit about the centre of this galaxy of ten thousand million stars. But what of our galaxy? Dayton Miller has made observations which may be interpreted as evidence for a galactic velocity of several thousand kilometres per second, but until confirmation is forthcoming it cannot be seriously considered. Undoubtedly, however, our galaxy is travelling through space as well as rotating about its centre. All the spiral nebulae have velocities relative to our system, and herein lies yet another mystery—why are these external far-off galaxies almost without exceptions speeding away from our galaxy with velocities of the order of several hundred miles per second? Are their velocities real or in part an illusory effect impressed upon the starlight as a result of its long journeying during many millions of years from one galaxy to another? Are these other galaxies and our own to be regarded as units in a super-aggregation having motions of its own, rotation, perhaps, and space velocity? Where is the centre of this super-system? If our giant galaxy be near it, then perhaps the recessional velocities of the other galaxies are to be explained as are the outward moving stars along each unwinding arm of every spiral galaxy —the super-system is perhaps a super-giant spiral!

These are questions to which to-day no answers can be given. The mystery of matter, the mystery of light, the mystery of motion! They baffle yet they challenge us, they over-awe, yet they inspire.

How a Talking Film is Made.*

By H. M. Wilcox.

Operating Manager, Electrical Research Products, Inc., U.S.A.

After describing the two types of talking picture—those using film and gramophone disc combined, and those employing only film—the author takes the reader on a tour through a giant American studio. Finally he discusses the future of the "talkie," of which the theatre is only one of many proposed applications.

THE synchronization of sound with the motion picture is almost as old as the motion picture itself. Gaumont in France, and Edison in the United States, succeeded in producing talking motion picture machines in the late 'nineties, and in the early years of this century. Even though perfect synchronism was obtained, these efforts were not successful commercially due to lack of illusion, poor tonal quality, and inadequate amplification.

Early Inventions.

The recording of sound is also an old known art. As early as 1857 a Frenchman, Leon Scott, recorded sound vibrations on a piece of smoked paper attached to the cylindrical surface of a revolving drum. Forty years ago Edison invented the method of mechanically imprinting sound vibrations on a soft wax surface from which a permanent record could be obtained and any number of duplicates produced. Later Emile Berliner invented the "lateral cut" method of wax recording which is now practically the only method widely used for phonograph recording. All these methods used a mechanical system by which the sound waves, impinging on a diaphragm, drive the needle point back and forth as the wax plate revolves. Reproduction is the reversal of this process: a needle point, following a "wavy" groove, is driven back and forth, and through a short lever drives a diaphragm. These all-acoustic methods of recording and reproduction were so lacking both in loudness and naturalness that there was no illusion comparable to that of the moving picture.

About fifteen years ago a small group of engineers in the Bell Telephone Laboratories, probably the greatest acoustical research organization in existence, commenced a series of experiments which led eventually to the development of apparatus for electrically recording and reproducing sound. Turning instinctively to the telephone art, they made commercial a precision-type of transmitter; they adapted the telephone repeater to serve as a one-way amplifier, and they used their knowledge of vibrations to design new structures for recorders and reproducers.

The first application of the new electrical method of recording was made by the Victor and Columbia phonograph companies about five years ago, resulting in a great revival of the phonograph business which had been seriously affected by the radio. The success of this venture encouraged the Bell Laboratories to tackle the problem of synchronously recording and reproducing sound and motion picture. Where it had taken years to obtain acoustic results of sufficient fidelity to be of value commercially, it required but a few months to develop a special type of motor, any number of which could be electrically interlocked so as to operate at exactly the same speed. With this type of motor available, it was possible to drive any number of cameras and recording machines in exact synchronism with each other. The cycle of operations in recording is by way of microphone through amplifier to recording machine. In reproducing the cycle is reversed. From the disc the recorded vibrations are transmitted by a needle to an electromagnet; the resulting electric current is amplified and transmitted to a loud speaker, which is nothing more or less than a glorified telephone receiver. This is located at the back of the stage, immediately behind the picture screen.

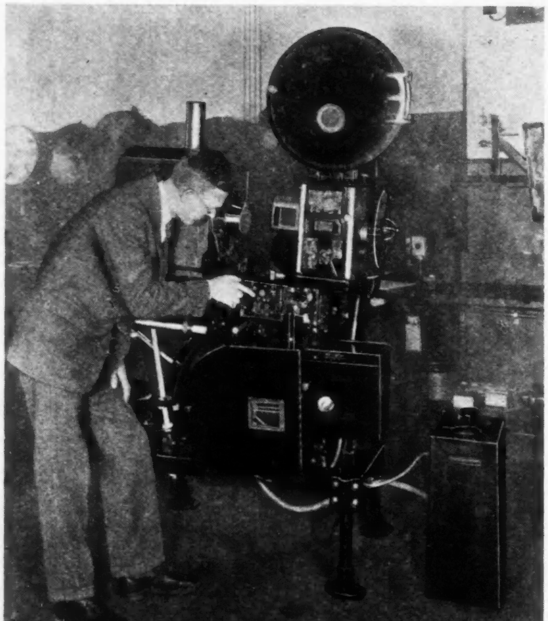
Photography of Sound.

Another method of recording utilizes photography, the record being made at one edge of the motion picture film; the variable current representing the sound waves causes two tightly stretched wires placed closed together in a magnetic field to vibrate in exact conformity to the vibrations of the sound waves. A bright light is focussed through the aperture between these vibrating wires on to a moving piece of film, resulting in an impression consisting of a series of small parallel lines of varying density and distance apart. A variation of this method is to vary the intensity of the light source by connecting the wires leading from the microphone to the terminals of the lamp and projecting through a fixed aperture. The

* Reprinted by special permission of the author from the *Princeton Alumni Weekly*, U.S.A.

former method is called the light valve method; the latter the flashing lamp method. Both are in practical use. To reproduce a film record, it is passed through a bright beam of light focussed through an aperture on to a photo-electric cell, which is a form of vacuum tube having the property of generating an electric current when light strikes it. This current goes to the same amplifier as the current from the needle of the disc reproducer and thence to the loud speaker. The entire projector mechanism is driven by a single motor through mechanical gearing, so that with a record or film started right sound and picture must be in step.

This brings up a curious point. A film on which both picture and sound is printed can be out of step. The reason is this. The picture is projected while at rest. It passes the projecting light in a series of jerks, twenty-four to the second. The sound track must travel past the exciting light beam in continuous motion. Consequently it is necessary to print the sound image belonging to a given picture some distance away from the picture, so as to permit of a loop of film between the projection light and the exciting light where the intermittent motion can be converted into continuous motion. For the Western Electric reproducer the sound image is actually about fourteen and a half inches in advance of the picture, but the projector is so constructed that the picture and the sound image belonging to it pass through their respective beams of light at the same instant. If in threading the film into the projector the loop between the projector light and the exciting beam of light is not the correct length, then the picture and sound will be out of step.



MODERN "TALKIE" PROJECTOR.

This machine is designed to project both types of talking picture, that is to say, it will reproduce either from a film and separate gramophone disc, or from a film on which both motion and sound are recorded.

To the uninitiated the glamorous part of the motion picture is the producing end. However, the grease paint and the Klieg lights very quickly dispel all romance and the studio is revealed for what it is, a factory of intense activity and hard work, presenting an infinite variety of different artistic and technical problems, and taken as a whole manned by a personnel that for intelligence, resourcefulness, and application to their job is unequalled in any other industry. In my short contact with this business I have gained a vast respect for the motion picture producer.

The advent of sound presented terrific problems as the use of this new medium of expression necessitated revolutionary changes in the entire technique of picture production, from scenario writer down through the technical staff to the director and artist. Then after the picture was filmed and the sound was recorded came new problems of editing, cutting, film treatment, and so on.

And through all this transition period there was a certain amount of "screen time" that had to be filled. The public could not be kept waiting, and the large expenditures required made a continuous flow of income a vital necessity. The surprising part is not that some bad product has been turned out, but that a degree of excellence has been obtained in a short three years that compares favourably with the silent picture product after thirty years of development.

Let us take a short trip through a studio. We enter the stage, perhaps 90 feet by 125 feet and 35 feet high. In speaking the voice sounds dead and we notice that walls and roof are completely covered with some sound-proofing material which deadens the echo. This is important, for the microphone picks up echo just as readily as it picks up the primary sound, and unless this is killed the resulting records will sound "tubby," as though the performer were talking in a barrel.

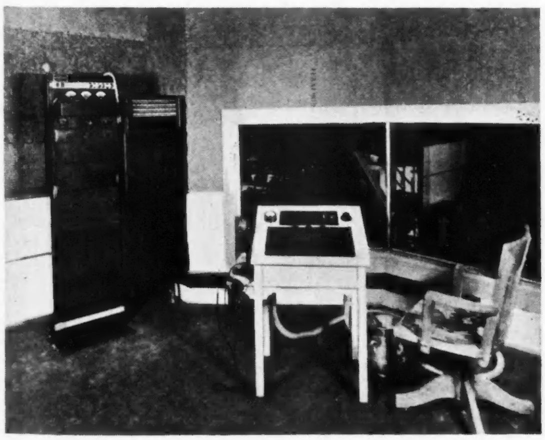
On one side about 20 feet above the floor a small balcony completely enclosed in glass juts out. This is the monitor platform located in an adjacent monitor room about one-quarter the size of the stage. The monitor man is to sound what the camera man is to

the picture. From his desk he controls the volume of the sound current received by each microphone; there may be from one to as many as six in use. A theatre reproducer horn is located in the monitor room and is cut into the transmission line just before the current reaches the recording machines, thereby providing the monitor with an exact reproduction of the sound while it is being recorded. Through telephones he communicates with the man in the amplifier room located in an adjacent building, and advises if the amplifying level is correct; he also directs the placing of the microphones on the stage and advises the picture director when it is necessary to alter the position of the performers with reference to the microphones in order to obtain satisfactory sound results.

Aside from the acoustic treatment of the walls, the microphones and the monitor platform, there are no evidences of " sound " apparatus on the stage other than the sound-proof camera booths, which will be scrapped just as soon as a silent camera is developed.

Next we walk over to the recording building; it may be nearby or it may be half a mile away; it may serve one stage or it may serve a dozen. It is usually a two-storey building with amplifier, recording, battery, and generator rooms on the first floor, and editing, cutting, and review rooms on the second floor.

The amplifying and recording apparatus could have been located at each stage, but the grouping of the electrical equipment in a central station gives greater flexibility in operation and permits closer supervision of the rather delicate apparatus involved. It also is more economical to operate both as to personnel and equipment load factor. The transmission of the



INSIDE THE MONITOR PLATFORM

From this desk the monitor man controls the volume of sound current received by each of the microphones in use in the studio below.

SOUND STUDIO IN COURSE OF CONSTRUCTION.

The enclosed balcony seen on the right, overhanging the room, is the monitor platform, where the sound control system is situated.

sound from any stage to the recording building is accomplished over an ordinary telephone transmission line. Power circuits are also necessary for driving the electrically interlocked motors on cameras and recording machines.

Before we have reached this point in our trip, some one probably has asked, " Which is the better, film or disc; and why both? " As far as acoustic results are concerned, there is little to choose. It is possible to record and reproduce substantially the same sound spectrum on both film and disc. From the standpoint of studio operations, the film presents the distinct advantage of making it possible to stop and start action at any time, whereas the cutting of a record on a wax disc should be continuous. The editing and cutting of the completed picture is also much simplified by the use of a film, and after release any requirements of the various censorship boards can be met by merely cutting out the parts objected to. The reason for both methods is that the disc method was developed first and ready first, and the disc method of recording is an old known art. It was several months after Warner Brothers made the first releases of Vitaphone talking picture subjects in August, 1926, before the film method was ready. During this time, a substantial inventory of productions have been created. Furthermore, the newness of film technique made results on the record more reliable and uniform in the beginning. Fox adopted the film through his interest in producing the sound news reel, since the film is the only practical medium for news reel work.

When the other large American producers—Paramount, Metro-Goldwyn-Mayer, United Artists, First

National, and Universal—were granted licences by Electrical Research Products, Inc. (a subsidiary of the Western Electric Company) in the spring of 1928, it was decided to leave the question of the recording and reproducing medium open and to instal both types of recording machines in their studios. Except for the recording machine, these two systems are identical.

From the distribution standpoint, the film also presents some obvious advantages. Transportation charges are less and, although the initial cost of a print is perhaps thirty times greater than the initial cost of a record, a print can be used for many weeks, whereas a record will not give satisfactory results for more than a few days.

As regards the possibilities of the future, what does the talking film lead to? and what is its social significance, if any? Well, it does just this. It affords the means to take to the many what was formerly reserved for the few. This applies not only to the amusement field, but also to education, commerce, and the religious field.

Is it not possible that the sound motion picture may be the instrument for bringing about a better understanding between nations and furthering the movement toward universal peace by affording the opportunity of presenting to the masses of each nation an almost living replica of the leaders and great men of their nations? Mussolini, for instance, has already been seen and heard by millions of Americans, who have thus had an excellent opportunity to judge his personality.

When the Chevrolet automobile adopted the four-wheel brakes, over ten thousand mechanics throughout the country had to be instructed in their adjustment. How much cheaper it would have been to have recorded detailed instructions of this operation and distributed this film to service stations throughout the country. Amusements, therefore, are but one of the smallest of the fields in which the talking picture can be of substantial value.

The "Next Step."—X.

Next Steps in Medicine.

By A. E. Boycott, F.R.S.

Graham Professor of Pathology in the University of London.

The trivial complaints of yesterday will be the serious diseases of to-morrow, and it is in this direction that organized enquiry must progress. One of the urgent conditions is more first-hand study in our hospitals.

If anyone knew what the next steps in medicine were or ought to be they would have been taken already. Progress has so often been achieved as it were by chance rather than by following out some well-defined track, that prophecy is impossible, though a certain amount of speculation may be legitimate and profitable. Some of the outstanding advances of recent years have come from the logical practical application of principles which have long been pretty well understood. Such is the control of diphtheria. Schick's discovery of a method by which those who are susceptible to diphtheria can be easily distinguished from those who are not was the last link in an old chain: by sorting out children in this way and making the susceptibles resistant by artificial immunization, it should be possible to abolish diphtheria altogether, or at any rate to reduce it to the position of a negligible disease: such difficulties as remain in the way of this ideal are administrative, not medical or scientific. In this category, too, we may place the general improvement in diagnosis and the general raising of the level of medical practice which, following the traditional paths of instructed commonsense, are no less real because they are difficult to define briefly.

But most of the dramatic jumps by which medicine has progressed lately have come by accident, and they have come not from the study of medicine itself but as by-products of the pursuit of animal physiology. What von Mering and Minkowski had in the back of their minds in 1889 when they found that removal of the pancreas caused a profound disturbance of sugar metabolism I do not know: they may or may not have been aiming at diabetes, most probably they were seeing what would happen just out of curiosity. However that may be, their observation has eventually crystallized into the commercial article insulin, which now makes it possible for so many diabetics to lead active and useful lives. Similarly, an academic study of the influence of various diets in the regeneration of blood led to the discovery that eating a good supply of liver will practically invariably remove all the symptoms of pernicious anaemia and restore the patient to normal life, though it can hardly be said to cure the disease because the symptoms soon return

if liver is omitted. Incidentally, we learn also that butcher's offal is properly included in our menus however deficient it may be in gentility. Indeed, the whole of our present enthusiasm for vitamins has originated in the laboratory rather than the wards.

The Process of Discovery.

Historically it is perhaps true that dietary troubles from vitamin deficiencies arose because physiologists thought they knew much more than they really did about the things which were requisite and necessary for the body. So long as men were content to eat what the cumulative experience of sensible women provided for them, all went fairly well. But under unnatural circumstances, away from family life, the men in the Japanese navy and the coolies collected on Christmas Island ate a diet which any physiologist would at the time have passed as reasonable. In the process of discovery—for discovery is a process, not an event—Lunin and Socin showed that the analysis of their fellow physiologists had missed some essential components of a satisfactory diet and Hopkins indicated where they could be found. Hence vitamins, which, for all the absurdities and extravagancies with which they are associated, are one of the great advances of modern medicine.

If medicine in the past has progressed along some such lines as these, where are we to look for the future? Medicine will no doubt continue, very fruitfully, to snap up any germane discovery made in any field of natural knowledge and use it for its own special purposes. No one knows whence useful materials may be gathered. Radium is one of the great landmarks and signposts of knowledge, and its importance in the pilgrimage of the human mind is neither greater nor less because it has chanced to be an important therapeutic agent. Such contributions from physics and chemistry will be, we may guess, relatively uncommon. It is from the biological sciences that we should naturally anticipate more help. Physiology has proved its worth as the basis of medicine over and over again since men's curiosity made them try to find out how the body worked. General biology, zoology and botany have also been fruitful. If indeed medicine is, as has been said, a branch of applied biology, it is evident that we must look to biology as a whole as the final foundation of medical practice. The biological sciences are, of course, worth cultivation for their own sakes: if they were not, they would deserve attention for the sake of medicine. And in this country they need more notice than they get: the material equipment and personnel which are devoted to zoology and botany have been enlarged relatively little in the last fifty years. In consequence medical progress is retarded. There are, for instance, many problems in bacteriology which need much more knowledge than exists of how bacteria live and move and have their being, that is, of how they exist as lowly plants rather than as the causative agents of diseases. If botany had been encouraged as it ought to have been, the information would have been available for medical bacteriologists when it was wanted: as it is, it does not exist.

But it is a poor science and a poor art—and medicine is both—which has to look for its advancement to the crumbs which happen to fall from other disciplines. It is difficult to doubt that medicine will make the greatest progress by working at itself. Curiously enough this is what modern medicine has largely failed to do. "Medical research" in this century has generally meant work in the laboratory rather than at the bedside. Meanwhile the facts and phenomena of human disease remain inchoate and uncertain, and the questions arising from them which need answers and to which it is possible to obtain answers are not defined. The extraction of a limited soluble question from the multitudinous sea of our ignorance is the most important step in discovery: once a question has been properly set, it is generally fairly easy to find the answer. Questions can, however, be satisfactorily defined only if the data on which they are framed are precisely known: as a distinguished clinician said to me not long ago, "the greatest need of medicine at the moment is the critical re-examination of what are believed to be the facts of disease." It is not at all a simple task, and one does not wonder that the easier problems of the laboratory attract so many of those who want to engage in investigation.

Medical Reforms.

The prime fact about a sick man is that he is ill, and his prime need is to get well: he is clearly not ideal material for the investigator. But with these paramount limitations, it is certain that ample advances will reward those who are prepared to take enough time and trouble—those, in short, who have enough devotion to make light of the difficulties. The discoveries about heart disease which the late James Mackenzie made when he was in general practice in Burnley are a shining example of the will finding the way. One modern reform in medical education has done much, and will do much more; the provision of whole-time professors of medicine, with appropriate staffs of assistants, in several of our larger medical schools, has given men with the suitable turn of mind a chance to devote themselves to their subject like any

other university teachers, without the distracting necessity of earning their living in practice. They can give their whole attention to knowing medicine and finding out about medicine, and in that atmosphere advance should be certain. It will be the more sure if better provision could be made in our hospitals for the maintenance of wards in which persons suffering from the particular disease under enquiry could be collected together for investigation. The present accommodation and more is needed for those who are seriously ill: the criterion of admission is the desirability and possibility of effective treatment; all sorts of different diseases lie side by side; systematic research is necessarily in the background. A hospital ward is an extremely costly laboratory, but something of the kind is really required where patients, not in many instances substantially ill, can be assembled to promote the progress of medicine as well as their personal well-being.

What are the topics to which, as we may guess, medicine will direct its attention in the future? The possible span of life seems to be no longer than it used to be; our vile bodies are what they have been for a very long time. The average span of life has been greatly increased, and a child born to-day has a statistical prospect of living about twenty years longer than I had at birth. The population contains a much greater proportion of old people: they are tired, anatomically and functionally, and are more content to reach the end than younger folk which explains the modern change in our psychological outlook on death. All this has been achieved partly by curing sick people but mostly by preventing contagious diseases. Death has been averted and with it much ill-health, for unfortunately diseases such as scarlet fever or measles leave many survivors crippled in one way or another. The great killing diseases due to bacteria and similar agents are far less important than they used to be in this country: smallpox, typhus, typhoid have nearly gone, even tuberculosis, bad as it is, takes only a tithe of its former harvest: the death rate of children under one year has been halved. Pneumonia alone is as frequent and fatal as it used to be.

Colds and Headaches.

It follows that the business of medicine henceforth will be to prevent ill-health rather than to prevent death. People wonder sometimes why there seems to be room for more and more doctors in our community when the death rate is so much lower than it used to be and when we are, we believe, a good deal healthier than our forefathers. The reason is that our demands in health have grown with our blessings: what Pepys would have called "very well" we should describe as "so-so," and while our grandfathers sent for the doctor because they feared they were sick unto death, we ask him to come and see us because we suspect that we might possibly be going to feel a little seedy to-morrow. The trivial complaints of yesterday will be the serious diseases of to-morrow, and it is in relation to these that organized enquiry is so badly needed and so difficult to achieve. Colds and catarrhs, rheumatics and megrinous headaches are between them responsible for more human unhappiness and inefficiency than any other diseases at the present time in this country. A disease which prevents young people doing their work is plainly of more practical importance than one which kills the aged. Yet of these three conditions (which perhaps represent many more separable diseases) we know neither the cause nor (with some reservation of aspirin for headaches) the cure. On our present standard of health they are all serious; any advance in our knowledge of them and our power to control them would be a real step in medicine. At present, in common with other ills which do not kill, they are a splendid field for ignorance and quackery.

Inheritance.

The other line to which it seems inevitable that medicine should pay increasing attention is constitution and inheritance. In old days a person's "diathesis" was an important thing and was liable to determine what diseases he had and what he escaped. During the nineteenth century the efficacy of external agents in causing illness came more and more to the front, and as bacteria and poisons replaced miasmas and stellar conjugations as actiological factors so the make-up of the individual declined in importance. The pendulum, of course, swung too far. Genetics has in this century impressed on us once again the reality of constitution; it is no longer a nebulous expression of vague observations. And we can hardly doubt that the understanding of the factors which determine the bodily and mental configuration of human beings will be an important part of the work of future hygienists. There is abundant evidence that closely-allied races of animals obtained by artificial breeding may react very differently to experimental infections. No doubt the same thing is true for man. As the eugenists have found, it is extraordinarily difficult to disentangle the data of human inheritance. Sincerity will ultimately solve at least some of the problems, and nature as well as nurture will then be a live medical interest.

Science Aboard the "Carnegie."

By J. P. Ault.

Commander, and Chief of the Scientific Staff.

The purpose of the "Carnegie" cruise was outlined by the author in DISCOVERY *last year, when this American research ship set sail round the world. The following extracts from his new report describe some experiences so far encountered on the voyage. Another instalment will appear next month.*

WE have now completed the longest stretch of the whole three years' cruise, from Balboa, Canal Zone, to Callao, Peru, in eighty-one days, with a stop of six days at Easter Island.

Heavy Seas.

For the first two weeks (from 25th October, 1928) it rained every day and every night and often in between. The wind blew steadily from the south-west as if to deny us entrance into the Pacific, so we made a long tack to the south, gaining a little westward as the wind changed back and forth, but not making enough to clear the coast of Ecuador. We ran the engine a few times when the breeze went light, in order to keep closer to the wind. Then we made a long tack to the north, hoping that Boreas would let us slip through, but again he proved stubborn and perverse. We passed close to Malpelo Island, an isolated barren rock, one mile long and 846 feet high.

Finally, on 8th November, after seven days of continuous struggle, when we were too close to the coast of Ecuador for comfort, and when our petrol supply was low, considering the three months ahead before we could replenish, the wind shifted to the south enabling us to proceed westward. The Gulf of Panama is one of the most difficult localities of all the oceans for a sailing vessel to leave. Sailing directions give due warning of this, so we were not especially selected for punishment. The delay gave us a fine opportunity to secure a number of ocean-stations in this interesting region. The salinity or salt-content of the upper layers of ocean water was very low, due to heavy rain and to the amount of fresh water pouring into the Gulf. The region is featured also by unusually strong and varying currents.

On 6th November, just before the wind changed, the cook was taken sick, with a steadily increasing fever. Three days before this the oscillator had ceased to operate while Soule was getting the depth at an ocean-station. We could not think of giving up the fight and returning to Balboa. The question was whether we should struggle on south and leave the cook at Guayaquil, or put him ashore at the settlement on the Galapagos Islands, where he might be interned for a year before a vessel would pick him up. We decided to carry on for a day or so and make sure. Four days later the doctor told me that the fever had left the cook and that he hoped to have him on deck soon. So things began to cheer up.

With the oscillator out of order, we can only estimate the ocean-depth in general from the chart, and very few soundings have been made in the regions we were to traverse. So we cannot determine beforehand how far down to send our water-bottle and thermometer series unless we first send down the bottom-sampler on the piano wire.

Ocean Ridge Discovered.

At station 40, about one hundred miles west of the Ecuadorean coast (in latitude 1° 32′ south and longitude 82° 16′ west), we were not planning to secure a bottom-sample, but were sending the water-bottles down to 10,000 feet, the depth given on the chart being about 11,000 feet. After 5,000 feet of wire had been let out, while stopping to attach another water-bottle, the engineer at the winch controls told me that he believed we had reached bottom, since the reel had slowed down for the last sixty feet. On several occasions he had been able to determine in this manner when bottom had been reached, so we hauled in the wire. The last thirty feet of wire were tangled around the bottom bottle and lead weights, showing that they had been on the bottom at 5,000 feet. We at once sent a bottom-sampler down on the piano wire, striking the ocean bed and bringing up a small amount of hard rock fragments and globigerina ooze, small shells found over nearly the whole of the ocean floor. The snapper jaws were bent, showing that they had struck hard bottom. This new mountain ridge, the existence of which the charts do not hint, we named the Carnegie ridge. It rises about 6,000 feet above the general level of the ocean floor in its vicinity.

With the change of wind we were at last on our way westward, and on 11th November sighted the first of the Galapagos Islands. Much to our regret we

did not have time to stop. These islands appear rather barren from the south. Isabella Island had a beautiful though small lava cone, where lava had boiled up out of the side of the mountain and then overflowed, breaking down the side of the cone toward the sea.

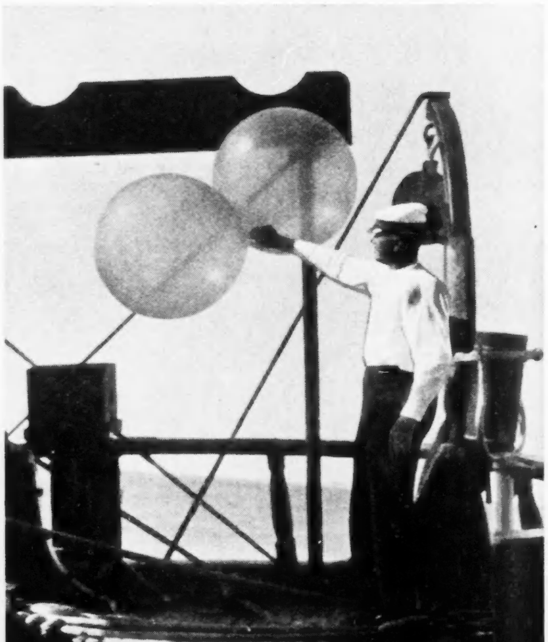
In measuring ocean depth the failure of the oscillator already referred to was a great handicap at our ocean-stations, for because of it we lost much valuable information over regions where no soundings had been made. Since the microphones for listening to the echo were still in good order, I began to cast about in my mind for some method of making a noise in the water, such as exploding a bomb, which might serve to return an echo from the bottom, the time-interval to be measured with a stop-watch. Paul suggested making up a chemical bomb, but we lacked sufficient materials. I thought of the powder for use with the life-line gun, but there was not enough to last very long. Finally it occurred to me that some way might be devised of using the shot-gun shells given us by Dr. A. Wetmore, Assistant Secretary of the Smithsonian Institution, for securing specimens of birds to be found on the various isolated islands to be visited. So I put the idea up to Leyer, the chief engineer, to devise a shot-gun.

Ten days after the oscillator went out of commission, Soule was again getting ocean-depths. Leyer had used a piece of brass pipe, twenty feet long, fitted at one end with an iron shell holder just long enough to cover a shot-gun shell, the holder being unscrewed to remove the fired shell and for inserting a new one. This end of the pipe is thrust two feet into the water, the engineer holding the other end in his hand on deck, usually on the main deck opposite the microphones. When Soule is ready at the listening head-phones in the laboratory, with stop-watch in hand, he blows a whistle, and the engineer lets go of the firing pin, which slides down the twenty-foot brass tube, and strikes and explodes the shell under water. Two shells are usually used, for checking, and the second echo is often heard, thus giving four values of the time-interval from which the depth is determined. The accuracy of this method was reckoned as $\pm$ 650 feet, and by comparison with seven depths as determined with unprotected thermometers, calibrated for pressure, the shot-gun method gave depths, on the average, about 650 feet too shallow. On occasions the agreement was remarkable.

We counted the number of shot-gun shells on hand and estimated that we could measure the depth twice daily during the remainder of the cruise to Callao. This was done, with a few extra soundings when required. When sounding in 1,000 feet near the coast seven echoes were heard, the interval between the shot and the fifth echo being measured. Such was the force of the shot that it appeared to those sitting in the cabin that when the shot was discharged the vessel had struck a rock. Once Seiwell was on the outboard platform arranging the silk net on the plankton-pump. Leyer unwittingly fired the gun just behind him. The vessel rolled a moment too soon, bringing the end of the gun near the surface as the shell exploded. Seiwell jumped as though blown up, the surprise was so great.

We were now in the region of the equator, with fairly steady south-east trade-wind. The temperature of the air, ranging, as it does, from 68° F. to 75° F., was not at all tropical. The following two and half months were featured by excellent weather, light winds, smooth sea, cool temperature, with very little rain or fog, and with only one short gale. The temperature never exceeded 75° F. and was as low as 59° F. for only one or two days, while the vessel was in the region of latitude 40° south. Blankets were used every night.

During this cruise we used for the first time a new theodolite loaned by the U.S. Navy Department for



MEASURING THE WIND.

The author is releasing two of the balloons used in conjunction with a new measuring instrument tried out successfully for the first time on the *Carnegie*.

observing balloon flights at sea. This instrument is constructed with special tripod and gimbal so that it can be kept fairly level as the ship rolls and pitches. The changing azimuth or direction and the changing altitude of the balloon can be measured as the balloon steadily rises at its average rate of about 600 feet per minute. Forty-four flights were observed. The balloon is filled with hydrogen gas from a pressure tank until it reaches a diameter of about three feet. It is then released to go whither the direction and velocity of the wind at various heights may take it. During the first ten minutes readings are made every thirty seconds, then every minute until the balloon disappears. Torreson operated the theodolite, Scott called out time and recorded, and the writer usually followed the balloon with a sextant, to measure the altitude.

The use of both theodolite and sextant saved the flight from failing many times. When the vessel would roll heavily and the balloon was changing its direction rapidly, it was difficult to follow and was lost frequently. By having the altitude from sextant readings it could be picked up again. On one occasion the balloon was followed for sixty-four minutes, but the average time was twenty to thirty minutes. With strong trade-wind it usually disappeared in fifteen minutes. Thus we secured excellent determinations of the direction and velocity of the wind at different levels, from the surface up to heights of from two to six miles.

For future aviators flying between San Francisco and Yokohama, we hope that sufficient information may have been secured, so that they will have the aerial map of wind-directions and velocities complete, and thus may be able to choose the proper altitude levels for the most efficient flying. This information is being secured from all parts of the world, the "Deutsche Seewarte" being especially progressive in instructing officers on commercial vessels in the use of these sea-going theodolites and installing the proper equipment on many vessels. Peru, also, is very progressive in flying, having at present three routes in operation, Lima to Arequipa in the south, Lima to Talara and Guayaquil in the north, and a route to Iquitos on the Amazon from La Merced, on the east side of the Andes. We are to co-operate by observing several balloon flights at their landing fields at Lima. While at Lima we made flights to a height of 12,000 feet to determine temperature- and humidity-changes with altitude, Parkinson, Torreson, Scott, and Jones going up for the purpose in a new seven-passenger monoplane.

The securing of bottom-samples was now being made a regular part of the oceanographic programme. Several types of bottom-samplers were tried. None worked perfectly, but the snapper type as improved by Dr. Vaughan and which he had made for our use proved to be the most satisfactory. We would let it go down with jaws open, as rapidly as its fifty pound weight could take it. Upon striking the bottom the wires go slack, the weight releases the catches which hold the jaws open and they close, snapping up about a pint of bottom-mud or ooze, a spring keeping them closed.

LOWERING A PLANKTON PUMP.

This instrument collects samples of the minute water organisms or "plankton," which make up the food supply of the acquatic world.

At times the snapper does not close, but even so enough mud sticks to the inner walls of the irregular-shaped jaws to give a good sample. Once we sent the heavier Meteor tube down, and it was forced into the bottom for a distance of two feet, bringing up an excellent sample. The second time it was used, it stuck too tightly in the mud and the wire broke.

Jewelry designers should examine this bottom-ooze under the microscope. If they did they would see intricate and beautiful designs and structures almost too perfect and elaborate to be copied. These are the shells of organisms which used to live in the upper layers and which, having passed through the life cycle, have drifted to the bottom and been accumulating through the ages. When examined under the microscope, this blue, green, and greyish mud opens up a new world for investigation. Most of this bottom material goes under the name of red clay, blue mud, or radiolarian and globigerina ooze.

Sending a sampler to the bottom sounds easy, but its execution has its difficulties. A small steel wire, 0.9 mm. in diameter, is used because of its light weight and because it offers very little resistance in passing through the water. By watching it pay out with the fifty pound snapper on the end, we can tell rather easily when the bottom is reached and the strain released. Automatic devices have been provided for this purpose also, but with the rolling and pitching of the vessel it is best to keep a strain on the wire by means of a rod held in the hand. Sampling the bottom is Erickson's job. If he fails to get a sample of the bottom at a given trial he has to send the snapper all the way down again.

Sometimes the vessel is drifting so rapidly that the wire stretches out to windward at so great an angle that we do not have wire enough to reach bottom, so we sadly haul it in again to await a better day. Occasionally we send the bottom-snapper down on the end of the 4 mm. aluminium-bronze wire.

And so the busy days go by as we wander down through the latitudes towards Easter Island.

More About Caligula's Barge.

By Daphne Shelmerdine.

During the summer the first of Caligula's barges has been completely uncovered, with disappointing results to those who hoped for historical treasures. On the other hand, it is still possible that the remaining work of excavation may reward the persistence of the Italian engineers.

It is a year ago since Signor Mussolini, in October, 1928, set in motion on the shores of Lake Nemi the pumping machinery which was to drain the lake and reveal the Emperor Caligula's ships, sunk there nearly two thousand years ago. Now the first ship has been uncovered. On the exposed shore, from which the water has been drawn away, lies the great wreck of the Emperor's barge, once probably the scene of imperial feasts, resplendent with coloured marbles and bronze ornaments.

The draining of the lake is a truly Roman exploit and appeals enormously to the Fascist mind. In the long history of attempted discovery, from the days of Alberti and de Marchi to those of Eliseo Borghi, many treasures have been taken from the ship, timbers have been wrenched away and much damage done to the wreck. It remained for the Fascists to undertake its complete exposure, and they appropriately signalized their first triumph, when last April a fragment of the ship appeared above the water, by fastening the Italian flag to the rotting timber, a photograph of which appeared in the May number of *Discovery*.

So now the first ship lies revealed, 200 feet in length, and wreck though it is probably a good deal may be learnt from it about Roman shipbuilding, although the barges were apparently designed as houseboats and not for motion. Of the enormous copper nails used in its construction there is already a goodly display in the Museo delle Terme at Rome, where also may be seen parts of the missing woodwork; but a good many of the beams are still in position intact on the ship's sides. As the water sank it was seen that the whole wreck was covered and embedded in mud, and would have to be cleaned before a detailed account of its structure could be given. The ribs of the hull are apparently about 48 centimetres apart, and the ship's sides seem to have been strengthened, between the exterior lead plates and the wood, with a thick felt-like fabric.

The interior of the vessel was filled with such a mixture (*tale un miscuglio*, as the Italian newspapers had it) of mud and stones, broken timbers with their protruding copper nails, lead plates from the exterior of the ship, and pieces of marble pavement, that it will be some time before the inside of the barge is really visible. All the soil dug out has been meticulously examined under the direction of Professor Cultrera for anything which might reveal the history of the ship or be of help in its reconstruction. Probably these sunken barges suffered no dramatic end in the days of their glory as the Emperor's floating palaces,

but were abandoned after his death and slowly decayed and sank. Perhaps they were despoiled of their finest treasures as they lay decaying on the surface of the lake, hundreds of years before the nineteenth century divers lent a hand in the pillage and raised the fine bronze heads of lions and wolves and the Medusa.

Another bronze wolf's head with a ring in its mouth has been discovered by divers during this year's pumping operations, and the photograph shows its fine workmanship. It was probably more ornamental than actually useful for mooring the heavy vessel. Possibly there are more treasures awaiting discovery in the mud and in the second barge, as yet uncovered, which lies in deeper water and completely overgrown with vegetation. On the shore, where also excavators are busy in the Sanctuary of Diana, the round altar here illustrated has been unearthed, a circular base with broken columns lying beside it.

Further discoveries on the shore will be awaited with as much interest as those from the ships. Diana's grove has been excavated several times before; as early as the sixteenth century by the Frangipani, and last century by the Orsini and Lord Lumley. Votive offerings to Diana have lately been found in the mud on the shore, but it is not likely that a further lowering of the water would reveal anything in connexion with the Sanctuary. In the past the level of the water was probably higher than it was last year before the lake was drained, and further discoveries must be looked for beneath the deposits of soil on the shore.

At the present moment the shore has a scarred and desolate appearance, the work of excavation and the receding water making havoc of its beauty. Fine trees that grew at the water's edge bear no leaves this summer. The water has now been lowered

THE ALTAR OF DIANA.

The size of this altar, unearthed during the summer on the shores of the lake, may be gauged from the figure in the rear of the photograph.

WOLF'S HEAD ORNAMENT.

Though the ring would suggest use for mooring the barge, this head (discovered in June) probably served only as an ornament.

by 13 metres. The draining of the lake proceeded more quickly during the summer, thanks to the dry weather and the continued efforts of the engineering firm, Riva of Milan. By the end of May the iron suction pipes had already been lengthened by flexible pipes supported on pontoons, as foretold in these pages.

What will be the ultimate fate of the Emperor's barge, after its past splendour and its long burial? Can it be raised in fragments or in bulk, and where will it be housed? Will the water be lowered further to uncover the second deep-sunken ship? These questions are still unanswered. In discoveries of artistic value the present operations have been disappointing. Had the divers of the fifteenth, sixteenth and nineteenth centuries not been so zealous, there would be more for the Fascists to reveal to-day. The earlier attempts at treasure-hunting were very damaging processes. While, however, leaving their destructive marks upon the ships, they did not change the face of Diana's Mirror. It is now being destroyed in the name of Art and Science with Roman thoroughness—a magnificent Roman thoroughness which, to those to whom Lake Nemi is dear, amounts to Roman brutality. But Nature, as we say, or Diana, as we might have said centuries ago, will outlive Roman and Facist, and before long restore one of the loveliest mirrors that reflect her changing face.

With the Scientists in Capetown, 1929.

Now that members of the British Association have returned from the meeting in South Africa, which many of them coupled with a tour in the Dominion, full details of the proceedings are available. Our report discusses a few representative papers, in particular those dealing with Empire problems.

It is customary to hear the meeting of the British Association referred to as the annual Parliament of Science, and no doubt this title sums up exactly what the proceedings set out to do. In every section, from mathematics and engineering to economics or psychology, the programme surveys the latest research and puts before its own experts as well as those in other subjects a summary of new achievements. With the growing unity of science and the bearing which apparently remote studies are having on others in unexpected quarters, the value of the annual exchange of ideas which the Association provides cannot be over-estimated.

The present occasion, however, while not lacking in specialized discussions of the highest interest, was appropriately predominated by the idea of Empire, which influenced the choice of many prominent contributors to the programme. Following the example of the President, Sir Thomas Holland, who chose for his paper " The International Relationship of Minerals," Sir Robert Greig spoke on the subject of " Agriculture and Empire " in his address to the Agriculture Section, and other proceedings included a report on " Educational Training for Overseas Life," presented by a committee of which Sir John Russell was chairman. In addition to such general problems of Empire, there were naturally discussions of particular interest to a Capetown gathering. The precedent was waived whereby the proceedings are opened with the address of the President, in order to allow Dr. J. H. Hofmeyr to welcome the members as President of the South African Association.

Africa and Science.

Under the title " Africa and Science," he reviewed the progress of learning since the previous meeting in the Dominion in 1905, which had " marked the commencement of an epoch in our scientific history, the epoch of the consolidation of the position of science in South Africa." Though notable work has been recorded there in several departments of learning, none has been of wider interest than the Dominion's contribution to Prehistoric Archaeology, which appropriately formed the subject of Professor Henry Balfour's address to the Anthropology Section. The latest phase of this contribution was presented in the findings of Miss Caton Thompson, who had spent the earlier months of the year in excavating the site of Great Zimbabwe. The date and origin of these remarkable ruins of ancient Rhodesia, described in *Discovery* last May, have so long remained a mystery that the lecture in which Miss Thompson presented her conclusions had to be repeated before a second crowded audience.

Some Problems.

Though the present review will deal mainly with the foregoing, which may be termed the " Empire Addresses," to suggest that the more general proceedings were of anything but the highest interest would show a lack of perspective. Lord Rayleigh's address, for example, on " Some Problems of Cosmical Physicals, Solved and Unsolved," opened up wide avenues of thought, and no paper provoked more discussion than the outline of his " Holism " theory which General Smuts presented. This philosophic conception, which the great statesman first made public in a book of that title published a year or more ago, is based on the observed tendency of the universe to form wholes. Another specialized paper on which remark may be made was the address given by Professor Seward, a Trustee of *Discovery*, on " Botanical Records of the Rocks." In pointing out how important it is to remember that the rocks which have furnished the earliest known remains of plants, are separated from the oldest known part of the earth's crust by thousands of feet of strata and by some hundreds of millions of years, Professor Seward remarked that the foundation stones of the world in the strict sense are unknown : we are still unable to answer the question—" Whereupon are the foundations thereof laid ? " He also quoted a saying of the late Professor Bury, referring to human history, but which is equally provocative of thought in its application to geology : " All the epochs of the past are only a few of the front carriages, and probably the least wonderful, in the van of an interminable procession."

Turning now to the Empire Addresses, in the order of their delivery, the first to be reported is "Africa and Science." Reviewing the progress made in the past quarter century, Dr. Hofmeyr said that most impressive perhaps of the positive achievements of the period, regarded cumulatively, have been the advances made in our knowledge of the diseases of plants, animals and men, and of the methods of preventing them. In 1905 we knew practically nothing of the plant diseases of South Africa. In that year the first steps were taken towards their scientific investigation. To-day a general survey has been completed, most of the important diseases have been worked out, and a highly efficient service for combating them is in operation. In 1905 also the Transvaal Crown Colony Government voted £1,500 as a first instalment towards the establishment of a laboratory for the investigation of stock diseases. From that has sprung the magnificent body of work in veterinary science, which has won world-wide recognition for the Onderstepoort Institution. More recently there has been founded the South African Institute for Medical Research, to which is allied the Miners' Phthisis Medical Bureau. The researches conducted there in the control of pneumonic infection, and the advances made in industrial hygiene in the fight against silicosis, have brought great lustre to these two institutions and to South Africa.

In other fields also South African scientific workers have won recognition. In geology, marine biology, the mathematical theory of determinants, the economics of gold production, and along several other lines of investigation, important scientific work has been done in South Africa; a succession of discoveries has been made throwing light on the origins of the human race; and applied science has by means of the conquest of distance in this far-flung Dominion, and of the construction of important irrigation and other engineering works, contributed generously to progress. It may, perhaps, be taken as a measure of the achievement of science in South Africa in one of its aspects that, while in 1906 the value of products of the land exported from the Dominion amounted to £5,928,000, the corresponding figure for 1927 was £27,815,000.

Mineral Resources.

The next Empire Address—Sir Thomas Holland on "Mineral Resources"—dealt with the subject in its international aspects, but clearly implied the opportunity of the English-speaking races to bring about the plan which its author advocated. After tracing the gradual rise of minerals vieing with agriculture as an economic factor—from the Industrial Revolution, which grew out of the close association of suitable minerals in England, to the Great War—the President of the Association said that the political boundaries of the nations, originally delimitated on considerations dominantly agricultural in origin, have now no natural relation to the distribution of their minerals, which are nevertheless essential for the maintenance of industries in peace time as well as for the requirements of defence. This circumstance gives a special meaning to measures recently designed on supplementary lines in Europe and America for the maintenance of international peace, measures which can succeed only if the facts of mineral distribution become recognized as a controlling feature in future international dealings.

Sir Thomas Holland continued: "If minerals are essential for the maintenance of our new civilization, they are, according to the testimony of archaeology and history, worth fighting for; and if, according to the bad habits which we have inherited from our Tertiary ancestors, they are worth fighting for, their effective control under our reformed ideas of civilization should be made an insurance for peace. In so attempting to correlate the facts of mineral distribution with questions of public policy, there is no danger of introducing matters controversial; everyone must agree on two things, namely, our desire and even hope for international peace, and consequently the necessity of surveying the mineral situation as developments in technological science change the configuration of the economic world."

Agriculture.

The other great source of the Empire's wealth—Agriculture—was the subject of the next address under consideration, and a tribute was paid by its author, Sir Robert Greig, to a valuable discovery made in South Africa. In pointing out that the grasslands of the Empire support at least 500 million animals, Sir Robert said that if all these animals were suited to their environment, free from disease and sterility, and sufficiently nourished, their value would be far more than doubled or trebled. South Africa, through Sir Arnold Theiler and his staff, has already demonstrated part of this possibility to the full. In discovering the cause of and the means of combating certain insect-borne diseases, these investigators have saved the Union millions of pounds. Equally spectacular, elsewhere, is the control of noxious weeds, such as the prickly pear in Australia and the blackberry in New Zealand. In the field of animal nutrition, it has been discovered that diseases may be

caused in farm stock by the absence of minute quantities of iodine, lime, phosphorus, or vitamins. The cure of rickets in pigs, and of styfsiekte and lambsiekte in cattle, by the administration of bone meal and salt and other mineral mixtures, has already saved hundreds of thousands of pounds to stock farmers. The application of the newer conception of balanced feeding, which we now have as the result of the studies of physiologists and biochemists, is yielding its return in increased production.

The intensive management of grassland in such great grazing countries as Australia, New Zealand, and Great Britain is only beginning, but already it is plain that production can be doubled under skilful management. Even the fertilizer or artificial manure, concerning which we know more than of almost any other agricultural improvement, has far wider fields to conquer than any which it has yet subdued. These great achievements give us the assurance that the application of pure science to agriculture will yield results of a value many times greater than the money expended.

The Zimbabwe Mystery.

Besides being the centre of valuable natural resources, South Africa has long been famous for its wealth of archaeological material, which only recently has been explored to any adequate extent. As Professor Balfour stated in his paper on "South Africa's Contribution to Prehistoric Archaeology," the vast African area lying south of the Zambesi appears as an inexhaustible mine of ancient relics. This is, probably, largely due to the successive waves of immigrant peoples having arrived in early times from the north. South Africa, though spacious, is a *cul de sac*, a land-terminus beyond which stretches the southern ocean, which arrested any further southward dispersal. We must picture the arrival, one after the other, of primitive peoples in various stages of culture-advancement, and it is natural to assume that the order of their arrival in the far south is indicative of their general culture-status. The more undeveloped peoples, less capable of defending their rights and of holding their own, yielded to the pressure of the more progressive peoples, before whose advance (due probably to similar causes) they gave way. Eventually they were forced down into the *cul de sac*, whose abundance of game animals, no doubt, afforded compensatory attractions, and where they could establish and maintain themselves unmolested, until a new immigration brought a fresh racial stock into the region and renewed the clash of cultures.

The process of sorting out the data, and of classifying and evaluating the Stone Age cultures represented in South Africa, is now proceeding apace, thanks to many keen researchers. Already several new names have been at least tentatively adopted for denoting various differentiated industries, which have been provisionally assigned their places in the chronological series. The earlier attempts, by Gooch and others, to reduce the material to some kind of classificatory order, had been followed rather more intensively and with varying success by J. P. Johnson and L. Peringuey; and within the last few years, in addition to numerous important papers by various authors in the scientific journals, the Rev. Neville Jones has published a very interesting book on the "Stone Age in Rhodesia" (1926). More recently still, Mr. M. C. Burkitt has dealt ably and suggestively with the general subject in his volume on "South Africa's Past in Stone and Paint" (1928), describing an extensive tour of inspection made at the invitation of the University of Capetown.

As regards the latest excavations at Zimbabwe, it is the more remarkable that the ruins are now dated at not later than A.D. 900 in origin, since they have been known to Europeans certainly since the sixteenth century. The most thorough excavations made before Miss Caton Thompson's new work—those of Dr. Randall McIver at the time of the 1905 British Association meeting—were vigorously attacked, especially by South African scholars, and it is therefore a happy conclusion to the controversy that the earlier results have been confirmed. What has now been brought to light entirely bears out Dr. McIver's interpretation, and Zimbabwe may be regarded as the seat of a vigorous native civilization, showing a national organization of a high kind of originality and amazing industry, which flourished in Rhodesia about a thousand years ago. Nothing was found to support the suggested Semitic origin of these buildings. A number of beads were discovered of Indian or Eastern Asiatic type, such as were current at various dates ranging from the seventh to the twelfth centuries.

More Problems.

The Zimbabwe mystery is probably now settled, but many questions of interest remain to be solved in South Africa, notwithstanding the general progress since the Association met there in 1905. Any members of the 1929 meeting who may visit Capetown for some future meeting are therefore likely to be as richly rewarded with further discoveries in archaeology, as well as being assured of witnessing still further progress in the scientific and economic life of this great British Dominion.

Bird-watching in the Orkney Islands.

By M. G. S. Best, F.Z.S.

The following notes of an observer in the Orkneys will interest many bird lovers. Besides describing those details of habit and appearance which are only discovered by patient watching, the author tells how in one case the islanders themselves have set out to protect the bird population.

THE feathered population of the Orkney Islands form themselves into two groups, the birds of the sea and shore, and those of the moors. Ducks and wading-birds are found on lochs on the moors and also on the big pools near the sea, where terns and gulls are nesting.

The Orkneys are highly cultivated. Farms large and small follow each other in procession from one end of the islands to the other ; the grey stone buildings of these farms look down from every sky-line, and where a country rejoices in such vigorous cultivation, birds have to betake themselves where they may. To find them the bird-watcher therefore has a good deal of ground to cover. The open fields of corn and potatoes, divided by barbed wire fences, with only an occasional stone wall, have no hedges to shelter small birds. One small wood only did we see, so tree-loving birds were non-existent, a curious and very interesting state of things from an ornithological point of view. Although cultivation is creeping up the sides of the hills, and encroaching on the moorland tops from every side, there are many wide acres which have up to now defied the plough and remain in all their untouched beauty. Here one may find grouse nesting amongst the heather, and be challenged by the cry of the cock bird standing on some outstanding hummock, a very watchful sentinel.

The Golden Plover.

On the lower slopes of the moor is heard the clear sweet whistle of the golden plover. It is interesting to see how very much deeper is the black of the breast and gorget of these Orkney birds than of those found on the Northumberland moors, or even of the birds in Scotland, a little further north. But the Orkney golden plovers still lack the pure blackness of the Norwegian birds. There is something most imposing and attractive in the beauty of their plumage. They have such an intensely black breast, gorget and cheeks, the narrow bordering of white standing out very distinctly, and even the golden-edged body feathers seem to have acquired a more brilliant hue.

But wherever one meets with these charming birds of the moors, they have the same delightful ways about them which make them such a joy to watch. The cock is so anxious in his care of his mate, as he stands stiffly upright on a commanding tussock of yellow moss which so exactly matches his own plumage. As long as there is the least suspicion of danger, he will keep on with his whistling, plaintive, sweet and very low when the intruders are some way off, but rising to a shrill syren-like shriek if the danger approaches too near to be pleasant. The golden plovers must find the nesting season a nerve-wracking time, but during the rearing of their young they become hysterical in their anxiety and wear themselves to shadows long before the chicks are old enough to fend for themselves.

Curlews and Wrens.

Common curlews are their companions on these flats, and they take life far more calmly. Veritable spirits of the moor they are, expressing all the wild freedom of open moor and of laughing burns, in that wonderful long-drawn call of their courting days—surely the loveliest cry of any bird ever created. Common sandpipers flew hurriedly up and down the burn, always in a desperate hurry, but these birds were few and far between, while wrens, very busy with their nesting affairs, were dodging in and out of the clumps of heather on the banks.

A long trek one day took us out to the western cliffs of the mainland. Except for an occasional wheat-ear, bird-life on the tops of the cliffs was very rare, but made up for it on the ledges facing the sea. Here were Fulmar petrels crouching on their ledges, solemn-looking birds with their large black eyes, and sociable, too, for the sitting bird has many visitors. One supposes that the bird which most frequently sails close by the nest, calling to her and sometimes alighting by her side for a few moments, is her chosen mate ; but she seems just as pleased to see any other of the Fulmars which go past on outspread wings, on purpose to have speech with her. On one occasion we saw four Fulmars sitting on the grassy slope immediately above the ledge of a particular nest, each waiting their turn to " call."

Guillemots, both common and black, were plentiful

THE ARCTIC TERN.
The female is here seen alighting on the edge of her nest, built in the heather. The Arctic tern is a fierce bird, and fights with vigour when attacked.

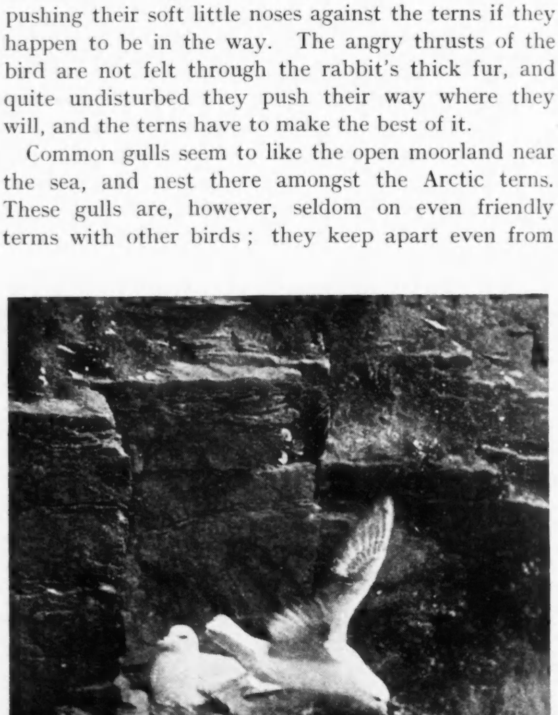
on the cliffs. The tysts, or black guillemots, abound on those which are more sheltered and provide stones for them to nest under, though rabbit-holes or tumble-down stone walls suit them just as well.

The chief object of our visit to these particular cliffs was to see the heronry at Lyre Geo, where these birds nest on ledges capable of supporting so large a structure as a heron's nest, while the narrower ones showed regiments of guillemots or razorbills. At the time of our visit, the young herons were half-grown, and standing motionless, stiff and straight on their nests, they were so like the cracks in the cliff-face that only by careful searching with our glasses could we find them. The birds were of the same colour as the rock and very little wider than the cracks. One does not expect a nestling heron to require exercise, but the ordinary position of herons' nests among the solid branches of trees does give some scope for activity on the part of the young birds before they launch themselves into the world. On the cliffs there was nowhere they could go, and to sit or stand up was all the change they could manage.

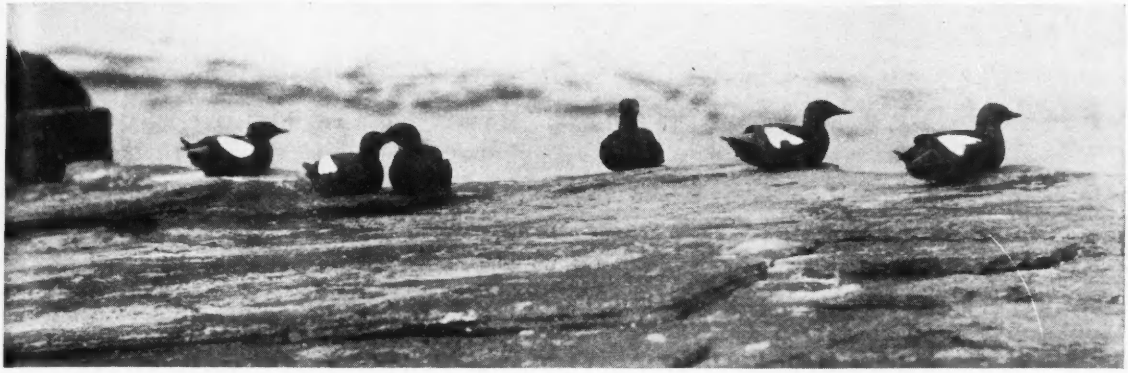
While returning to our car, we passed a large patch of tall blue lupins, with a slab of sandstone laid in front of them, with the request painted on it, "Don't pluck this flower." The lupins in Orkney were originally sown on the poorest portions of the bog land, to enrich the soil by taking nitrogen into it. Now the plants seed themselves to a great extent. Until the soil is of sufficient richness to produce a crop of some sort, lupins flourish there in abundance, and when the soil is ready, the lupins move themselves elsewhere.

Arctic terns are in abundance in many localities near the sea, nesting on one or other of the outer islands, amongst the young corn in the fields or on open pastures. The birds rose in an angry swarm to follow a small Shetland sheepdog who trotted near their nests, buzzing round him like bees. There is little difficulty in distinguishing the Arctic and common terns when on the wing, for the Arctic is much quicker and far more vicious when angry than its slower acting cousin. The Arctic knows no fear of man or beast. It will peck a man's head so fiercely as to draw blood even through a thick cloth cap, and on one occasion, when a large white calf wandered near the nest, contentedly munching the grass as it came, it was attacked with such force and persistence by the furious little bird that the animal fled for safety. The only beings I have seen really defy these birds are the rabbits on Farne Island. Towards evening, when the visitors have departed and the island is left in peace again, rabbits of every hue come out to feed. Unfortunately the terns have selected the ground immediately over the rabbits' holes on which to make their nests, and here they sit in a close-packed colony. The rabbits nibble wherever there is grass, and as this flourishes amongst the nests, here the rabbits feed, pushing their soft little noses against the terns if they happen to be in the way. The angry thrusts of the bird are not felt through the rabbit's thick fur, and quite undisturbed they push their way where they will, and the terns have to make the best of it.

Common gulls seem to like the open moorland near the sea, and nest there amongst the Arctic terns. These gulls are, however, seldom on even friendly terms with other birds; they keep apart even from



FULMAR PETRELS ON NEST.
The male visiting his mate on her nest in the rocks. The Fulmars are very sociable, and the sitting bird has many visitors.



GROUP OF BLACK GUILLEMOTS ON THE ROCKS.

their own kind and place the nest always at some distance from any other. These nervous, suspicious birds are difficult to photograph, as they take a long time to accustom themselves to a hiding tent, and stand for hours watching it, well out of range of the camera. These nesting areas are raided periodically by local farmers, who collect such eggs as they may find, on which to feed their calves, as it is said that the animals' coats are improved wonderfully thereby.

Passing along the roads we saw many peewits with almost full-grown young running with them. In fact, by the middle of June, peewits were gathering in big flocks, flying over the fields as if it were already autumn. Starlings also were flocking and sitting in rows on the telegraph wires.

Two of the outlying Orkney Islands were visited. On one of these we found inland lochs of fresh water, with flourishing beds of reeds, in which were nesting colonies of black-headed gulls intermixed with Sandwich terns. This island was one of the most perfect examples of bird protection it was possible to see. The islanders themselves protected their birds, knew where each different species nested and all about them. On crossing a grass field one noticed tiny cairns of stones, placed there to mark the nest of Arctic tern or ringed plover. We were shown the nest of a red-necked phalarope hidden in a little tuft of grass. The loch was shrinking rapidly with the dry weather, and the ground which had been covered with water when early nesting operations began was now dry enough to graze cows and sheep. The tethering-rope of some heavy animal had become twisted round a coot's nest, an erection built up nearly two feet high in a tuft of rushes. The eggs had begun to hatch, and many young birds were left dead in the nest amongst the remaining eggs, a very forlorn ruin.

The red-necked phalaropes were busy feeding in the loch or running after each other along the shore, and were the tamest little birds it was possible to find. The male birds were sitting, presumably, though we only saw the one nest, while the females were amusing themselves in their search for food. When a cock came off to feed, the hen joined him, and the two hurried round together, she driving away any other hen bird that ventured to approach. Occasionally we saw a female displaying before her mate, spinning rapidly round and round, pecking at the water as she did so. He paid no attention whatever to this performance, but continued his search for food in the desperate hurry that characterized all their movements.

Dunlins were on that same pool, but in a flock of ten or a dozen birds feeding some way out from the shore. We also observed some mallards, a pair of wigeon, and numerous coots, these last with their families strung out behind them. The Arctic terns were enjoying themselves playing about, some were in groups on the edge of the shore, preening their feathers, and keeping a watchful eye on a group of white stones standing in the water. These stones were evidently coveted positions, for directly one became vacant another bird was ready to occupy it. From the stones the birds could look down into the water and see their reflections below, and no doubt they fully realized how very beautiful they looked there.

Both lesser and greater black-backed gulls frequented the harbour at Kirkwall, competing with common gulls for titbits floating about the shore. They were also faithful followers of every plough in the district and must have been blessings to the farmers, for they never seemed satisfied but searched untiringly for food, until the ploughmen took their teams of horses home for the night.

Solving the Secrets of Heredity.

The following report sent to DISCOVERY *by the Carnegie Institution of Washington describes researches on heredity of the first importance. More than eight hundred generations of water fleas have been closely observed and factors determining their sex discovered. A clue is also afforded as to the origin of new species.*

THE Carnegie Institution recently celebrated the twenty-fifth anniversary of its Genetics Department at Cold Spring Harbour, Long Island, by a display of exhibits designed to show the progress it has made in solving the secrets of heredity. One of the exhibits which attracted attention had to do with the study of " water fleas "—a study which Dr. Arthur M. Banta and his assistants have been pursuing for many years.

" Water fleas " (Cladocera) are not fleas at all, but minute fresh-water animals found in great abundance in ponds and puddles the world over. They are really crustaceans, but derive their name from their jerky, swimming movements. Small as they are (a microscope is required for their study), their structure is exceedingly complex, probably as complex as that of any animal so tiny. They are of considerable economic importance since they constitute one of the agencies for converting the algae of fresh water into a form suitable for the fishes. Their particular interest to the biologist, however, lies in the peculiarities of their method of reproduction, the study of which throws light on fundamental processes involved in heredity.

During the open season the females produce eggs which develop into normal individuals without first having been fertilized with sperm from the male. This phenomenon is known as *parthenogenesis* and occurs normally in some worms, in plant lice or aphids, and among ants, bees and wasps. The eggs of Cladocera are deposited in a brood case which is within the body of the female itself (Fig. 1). Here the eggs develop, hatching into a form quite like that of the parent and becoming well developed before they are set free. All of the unfertilized eggs which are produced early in the spring hatch into females. Later in the spring or in early summer, when the ponds or puddles are beginning to recede and there is over-crowding and food becomes scarce, males begin to appear. At this time another curious thing happens. The female no longer produces large clutches of unfertilized eggs as at first, but, instead, deposits in her brood chamber clutches of only two each. Moreover, upon entering the brood chamber, these come in contact with sperm from the male and are fertilized. The structure of these fertilized eggs or " winter eggs " is visibly different from that of the earlier unfertilized ones. They are larger and their yolk is more uniformly granular. Furthermore, while the fertilized eggs are still in the brood chamber a thick, tough, dark coloured substance forms around the latter. Within this protective covering the eggs remain when the mother collapses, as she does when the ponds dry up or cold weather sets in. Weeks or months later, when conditions are right, they hatch. Although

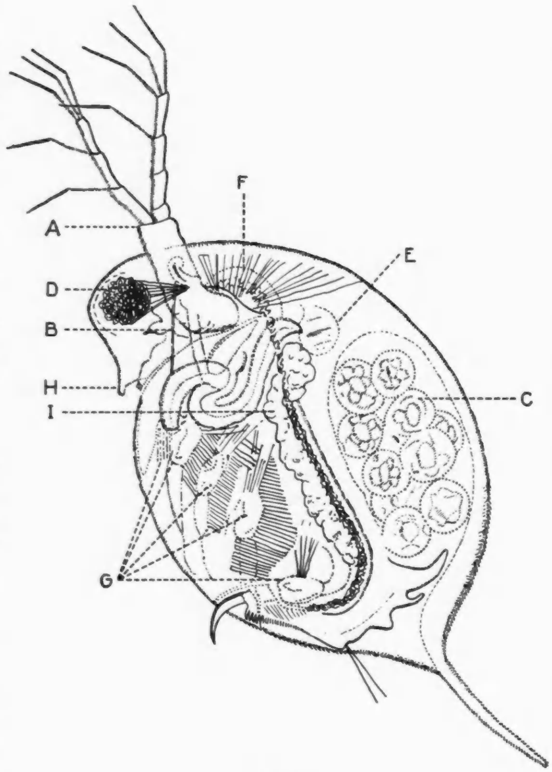


FIG. 1.

THE WATER FLEA.

Drawing of a water flea (*Daphnia longispina*) after Birge. Though these animals are no larger than the size of a pin-head their structure is exceedingly complex. (A) antenna; (B) brain; (C) brood case with developing ova; (D) eye; (E) heart; (F) intestine; (G) legs; (H) beak; (I) ovary.

unfertilized eggs produce some males, particularly near the close of the season, fertilized eggs or "winter eggs" never produce anything but females.

In Cladocera, obviously Nature has developed a method by which the race is carried safely through the unpropitious months of autumn and winter. At the same time the method insures an exceedingly rapid increase in population during early spring when sharp competition is waged with other animal forms for supremacy in pond or puddle.

Interesting as is the life history of these animals,* the geneticist is concerned with them because they throw light upon heredity. In most plants and animals, inheritance is complicated by the fact that the newly formed organism contains hereditary material (chromosomes) from both the father and the mother. This fact immensely increases the number of the possible character combinations which may be inherited. In the case of the parthenogenetic egg, however, only characters derived from the mother are present in the offspring; hence the daughters are all alike so far as their inheritance is concerned. This is an infinitely simpler situation, for it enables the scientist to follow traits which appear through a long line of pure descent.

FIG. 2.
EIGHT HUNDRED GENERATIONS.
Dr. Banta at work on some of the eight hundred generations of water flea which have been bred at the Carnegie Genetics D partment for experimental purposes.

Dr. Banta has obtained 867 laboratory generations from a given mother (Fig. 2). He found that the descendants all along the way even to the last generation, with but few exceptions, were as like the original mother as "identical twins" are alike in man. Occasionally, however, individuals were discovered which were noticeably different from the others in some particular. For example, Dr. Banta found one in his parthenogenetic line whose head, instead of being straight from the region of the eye to the tip of the beak, as is normally the case, was decidedly concave (Fig. 3).

To distinguish this character he called it "excavated" head. Inasmuch as the parthenogenetic young of this individual had "excavated" heads like the mother, Dr. Banta recognized that he had come upon what breeders call a "sport" and biologists a "mutant," that is, an individual in which some change in hereditary make-up has occurred which it is able to transmit to its offspring. Examples of such sudden departures from the characters common to the species are eagerly sought for. If the variation proves, upon further breeding, to be permanent, then the investigator knows that in all probability he is observing the effect of that very process which is responsible for the genesis of the countless forms in which life on earth reveals itself.

Inasmuch as Dr. Banta's work on inheritance in parthenogenetic reproduction was open to the observation that he was perhaps dealing with a somewhat abnormal type, he undertook a series of breeding tests to see if the "excavated" head character was heritable by the usual method of sexual reproduction, *i.e.*, according to Mendel's law. He mated individuals of the "excavated" head stock with stock having heads with normally straight fronts, and found that the character was transmitted to the offspring in strictly orthodox fashion.

Another mutation which Dr. Banta and his assistants discovered while working with the parthenogenetic Cladocera proved to be of more than usual interest. During a period of hot weather, a female was hatched which produced several broods of young. The broods which hatched when the temperature was low died; those which hatched during hot weather survived. This suggested that perhaps they required water of a higher temperature than that in which the animals usually thrive, which normally is not above 70° F. Mother and daughters were placed in a temperature of 80° which is usually quite unfavourable. They thrived. Further experiments showed that they were vigorous at a temperature between 77° and 86° and that they did not die until a temperature of 110° had

* Other details of "Water Fleas" were given in an article by the late Sir Arthur Shipley, G.B.E., F.R.S., *Discovery*, Vol. VI, p. 93.

been reached. The parent stock on the other hand promptly succumbs at about 100°.

This discovery is of particular interest because it affords a clue to the origin of races of animal life that thrive in water which is unbelievably hot. It seems probable, Dr. Banta thinks, that thermal strains in nature may have arisen not by a long period of acclimatization, as many have believed, but as the result of a sudden mutative change. Survival at high temperatures might well be followed by yet other sharp variations in the same direction until, in subsequent generations, adaptation to abnormally torrid conditions were finally obtained.

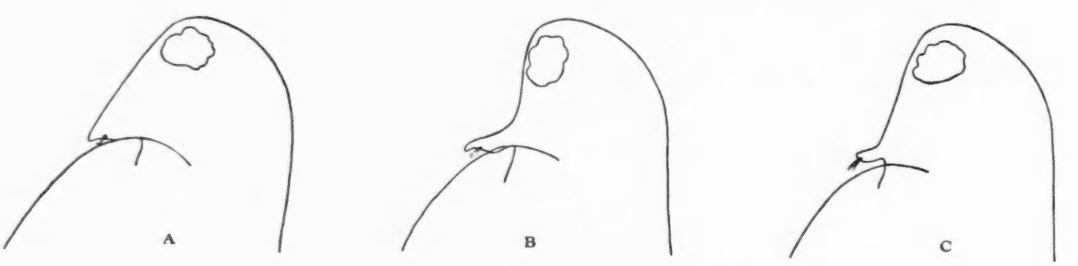


Fig. 3.

'MUTANT" CHARACTERS WHICH ARE HERITABLE.

This drawing, illustrating the mutation called "excavated head," shows :—(A) normal head form ; (B) excavated head mutation ; (C) excavated head plus another mutant character, "short beak." By a "mutant" character biologists mean one which is a more or less abrupt departure from characters common to the species, but which is heritable. It is believed that the countless forms of life have arisen through mutations.

Most students of heredity now believe that such abrupt changes in characters as "excavated" head and "thermalness" are due to changes in the germplasm of the individuals in which these traits first appeared. They also believe that no amount of body change or change in the environment can modify the characters of the offspring unless such changes affect the germplasm in a fundamental way. Many also believe that the process by which these mutations are had is a random one, one in which perhaps hundreds of bad mutations appear for every good one. Those that help the organism to make a better adaptation to its environment survive and accumulate ; those which do not are lost, because the individuals having them are handicapped in the struggle for existence and disappear. Moreover, it is thought that it is in this manner, through mutations, that all new forms of life have arisen. The precise cause of mutations, that is, of changes in the germplasm which produce changes in characters, is not known. Many think that the cause lies within the germplasm itself. On the other hand, evidence is available to show that, in certain instances at least, the germplasm of organisms is susceptible to the influence of factors in the environment.

Naturally Dr. Banta and the other geneticists working on similar problems are alert for evidence bearing on this matter, for it is fundamental. In this connexion a series of experiments with his parthenogenetic lines of Cladocera on the control of sex which he made is significant. As has already been said, whereas in Nature all of the parthenogenetic eggs of Cladocera produced early in the spring hatch into females, later on, when ponds and puddles begin to dry up, with consequent overcrowding and scarcity of food, then males begin to appear. Dr. Banta sought to learn if there was a causal relation between these external conditions and the increase in the percentage of males. The effect of crowding was first tried. He took a brood of young females all hatched from a single clutch of eggs. In each of certain bottles he placed only one female, while in each of other bottles he placed ten females. It was found that whereas the isolated mothers produced only female young, the crowded mothers produced both females and males. As the crowding was increased, the percentage of males increased (Fig. 4).

Dr. Banta also observed that the crowded mothers produced their young later than the uncrowded mothers, and that increase in male production was closely related to increased retardation in the production of the young. This suggested that male production is associated with the lowered metabolism of the mother. Following this lead, instead of crowding the mothers he sought to learn the effect of administering certain drugs and also of lowering the temperature, either of which tended to lower the mother's metabolism. The result in both cases was as expected—an increase in the percentage of males.

As a check Dr. Banta performed another experiment. He took two crowded bottles, each containing the same number of sisters. One bottle was kept as a control. To the other bottle he added a stimulant

with the thought that this would tend to overcome the retarding effect of the overcrowding. In the control bottle males appeared in customary proportions, but in the bottle containing the stimulant very few males were produced. These and other experiments, repeated many times, gave results consistent with the principle that male production is associated with a lowered rate of development and female production with a rapid rate of development. That is to say, in these instances changes in environment had affected the metabolism of the mother which, in turn, affected the sex of the offspring. The precise way in which this control operates in Cladocera, Dr. Banta has not yet fully discovered.

It has been learned that in most organisms the female sex has a chromosome organization different from that of the male sex. In man, for example, and in most animals, the male produces two kinds of sperm. One is called a female-producer, inasmuch as fertilization by a sperm of this type invariably results in female young. The other type is a male-producer, for it always gives rise to male young. The females of species whose males produce two types of sperm always produce but one kind of egg. In birds, butterflies and moths, however, the situation is reversed, for the male produces but one type of sperm while the female produces two types of eggs, male-producing eggs and female-producing eggs. Dr. Banta thinks it probable that there is a similar sex-determining mechanism in the germplasm of Cladocera, although this has not yet been fully proved. If so, then it follows that in the experiments cited, environmental conditions were somehow linked up with the working of this mechanism.

Although these and other experiments suggest that the sex of offspring can be changed by changing external conditions, Dr. Banta feels that scientists are still a long way from the point where this can be accomplished in the higher animals and in man. On this matter he is of opinion that if sex is to be controlled in the higher animals and in man, it must probably be done through controlling the type of sperm that is to accomplish fertilization. It seems exceedingly doubtful if the selection of sperm, the maintenance of life in the sperm, and the accomplishment of fertilization with the selected sperm are things that can be done in the near future. In the first place, these sperm are very small. It is doubtful if the male-producing and female-producing types can be distinguished under the microscope. Even though this were possible, it would be very difficult to separate and keep alive the selected sperm. It would also be most difficult to secure successful impregnation.

Fig. 4.
AN EXPERIMENT IN SEX CONTROL.
In an experiment in controlling sex in the "water nymph," a species of Cladocera, Dr. Banta found that by crowding the mothers the percentage of male offspring was increased. He accomplished the same result by administering drugs and also by lowering temperature. The experiment suggests that male production is associated with a lowered rate of development and female with a rapid rate.

In conclusion, it seems desirable to offer a word of warning lest the very moderate accomplishment in the direction of control of sex in Cladocera might be interpreted as providing a solution of sex control in general. No such claim is made; the control of sex in the higher animals and in man would seem to be far distant indeed.

Where Boys are Taught by Men.

By Capt. W. Hichens.

Late of Native Administrative Service, Tanganyika.

British administrators in Africa are adopting new methods of dealing with native customs which, though often barbaric, may serve a useful social purpose. In education, for example, the Nandi tribes subject their boys to a severe and definite period of training in manhood, which the author witnessed in official capacity.

THE question whether boys are best taught by men teachers who can instil a proper sense of manliness and courage, or by women who imbue chivalry and gallantry, is one of those problems now being debated by experts to which one might not expect to find any answer in so unlikely a place as the savage kraals of Africa, much less in the barbarous orgy of spear-blooding in which youthful warriors of Kenya's notorious Nandi and Masai tribes have recently indulged.

The Savage " Blue."

But as the savage puts it, no man is so clever that he can see the back of his neck, and there are things that the white man may learn even from the savage. This problem of making men out of boys is one which the savage has puzzled out in his barbarous way with remarkable success, the spear-blooding raids being one instance of the black man's thoroughness in testing his young men's courage, resource and skill. It is the young savage's way of taking his 'Varsity blue, for it is the great sporting event for which he can enter only after he has passed rigorous tests of valour, truthfulness, and memory, such as few youths even at our " toughest " public schools would care to face.

How many of our lads would like to confess, on penalty of being thrashed with stinging nettles, every prank of their boyhood, as a test of truthfulness? Yet that is one test of the great " passing out exam.," as it might be termed, which has been the event of the year amongst the famous Nandi of Kenya. This ordeal I saw scores of young Nandi boys go through with a cheery grin when I was camping amongst them during a savage " manhood term " not long ago.

As the prize for successful Nandi boys is a complete set of warrior's weapons, seven-foot spear, buffalo-hide shield, razor-edged sword and club—which they are apt to make use of by sallying off to spear some unwary herdsman of a neighbouring tribe—it was with a view to keeping a restraining eye on " rags " of that kind that I went to Kipkemboi's *ka* or village, a cluster of mud-walled, thatched huts standing out in the plains. Here for some weeks the old women had been busy making pots full of curded milk mixed with ox-blood, which the Nandi draw from the neck of living oxen by piercing a vein with a blunt-ended wooden arrow, before closing the small wound, after sufficient has been drawn, with mud and crushed leaves. These pots of curd were the " tuck-boxes " for the boys in their last school term, for curds are the Nandi boy's main food.

One clear night when the moon was new, marked the start of the manhood tests, when fathers and uncles from different villages brought in young lads, between twelve and seventeen years old, and handed them into the charge of a number of elderly men at Kipkemboi's. The lads looked somewhat scared, as well they might, for the next few days were to witness some strange happenings. Late that evening, after the boys had fed, the old men marched them in a troop over the veld into the depths of the forest a few miles away. It was a weird trek, in itself no small test of courage, for the night was very dark; hyaenas, which swarm on the Nandi plains, kept up a dismal moaning broken with shrieks of maniacal cackling laughter. Down by a neighbouring river on the forest edge, a pair of lions roared, first the lioness with a snarling, cattish bellow, then the lion, gruff, reverberant and irritable. The old men, wrapped in long oxhide cloaks, shuffled along without a word, the lads, nude except for flimsy cotton shoulder-cloths, padded after them, shivering, for the veld can be very cold at night.

Building a School.

We trekked for some miles into the forest, keeping close to the river bank, and then halted in a clearing, as dark as a pit, filled with mysterious, uncanny rustlings in the undergrowth. Great fruit bats squeaked and gritted their teeth as they flapped and crashed through the branches overhead, and answering owls hooted mournfully from the depths of the forest's gloom. Our trek had brought us to the first pink flicker of dawn, and while my porters put up my tent in a handy glade nearby, the old men and the lads plunged into the forest, soon to return with poles, branches and loads of grass with which they built

a large hut. Bare of all furniture except a few wooden stools which the lads had brought, this was to be their " school " for the next six months.

Building this hut took them two days' hard work, but the boys were up at dawn for the first ritual of the test. One of the old men, or *moterernik* as they are termed, set a wooden stool by the doorway of the hut. Here each lad sat on the stool in turn, while his head was well rubbed with salt milk and every vestige of hair was shaved from his scalp. When all had been barbered, the hair was collected and thrown into the forest in the direction of the rising sun, as an offering to the sungod, or Supreme Power, called by the Nandi *Asis*. Most people think that savages are godless pagans, but like most other tribes the Nandi revere the Supreme Power ; and reverence and worship of *Asis*, with many beautiful prayers is part of the education of the Nandi boy. When this solemn rite was performed to " cleanse " the lads' souls, a large dose of very nasty medicine was given to each boy to keep him physically fit. Like any British schoolboy they made faces over taking it, and the sight of their grimaces gave me painful recollections of the brimstone and treacle administered in my own schooldays !

Tests for Deceit.

Various tasks and instructions by the old men in tribal lore kept the lads busy until the next afternoon, when a mob of Nandi warriors in full war gear marched into the forest and, taking the boys outside the hut, made them sit down in a line. In front of each boy a warrior crouched, grim and scowling, staring the boy straight in the eyes as though he would read the very secrets of the lad's inmost thoughts. For nearly an hour those boys sat thus, wide-eyed, gazing into the stern eyes of those fierce-visaged men who were, in fact, testing the lads for deceit and cowardice. Any boy who quavered or became shifty-eyed had to sit for a further test and if he again failed to look his examiner eye to eye as an honest lad should, he was sent home in disgrace. But all the boys in Kipkemboi's camp passed this test successfully and were given an hour's rest for play and meals until sunset, when a great ordeal awaited them.

This, strangely enough, is akin to new scientific educational methods in some white schools, for it is believed to induce to strength of mental and moral character, as well as teaching judgment and reflection. It was a strange scene in this forest camp, as night fell and the stars flickered one by one in a purple sky, while the wild life of the forest awoke, the lemurs howling, jackal crying his staccato yelp, and the hyaena groaning his dismal moan. The boys again

SAVAGE " PRIZES."
Young Masai with the shields, spears and swords which they win in their savage training in manhood. The Nandi " school " closely resembles that of the Masai, and may have been copied from it.

filed out of the hut and sat on the ground outside in silence, to gaze at the stars, each wrapped in his own thoughts. Not a word was spoken as the boys sat thinking, each carrying out the instructions of the old men, to recollect as far as possible every single thing that had happened in their lives. The Nandi, it must be remembered, have no books or literature and cannot read and write ; but every Nandi lad who has passed the tests is a veritable encyclopedia of tribal knowledge, knowing the history, laws, customs, omens, witchcraft, and religion off by heart, besides the technical details of cattle farming, grain-growing, skin-breying and a score of other industries. Memory is most important to every savage and this is the first of many tests in memory and general knowledge he has to pass.

After an hour's silent thinking the lads faced an endurance test. Throwing off their clothes, they formed up in line and marched into the hut by the back door. Inside, at one end, the old men had built a kind of cage made of wicker, with two doors, at each of which stood two Nandi warriors holding in one hand a bunch of ububu beans, which sting about ten times as badly as our English nettles. In the other hand was grasped a small gourd closed by the thumb with a small piece of hide over its mouth.

The line of lads went down on all fours and crawled through this wicker cage and, as they crept in at one door and out at the other, the warriors slashed them in the face with the stinging ububu beans and, shaking those little gourds, let fall live and infuriated hornets on the boy's bare backs. It is some consolation that the warriors got stung as well ; and so, for that matter, did I, for those hornets were particularly vicious ! But not one of those Nandi lads called out, or even winced, but crawled through that cage as though they were white schoolboys going to the gymnasium. With

repeated coatings of clay and oil, the Nandi's skin is, no doubt, much tougher than a white lad's but, though barbarous as most savage customs are, it was a gruelling test of courage.

At the other end of the hut, wrapped majestically in a fur cloak, with a lion's mask ferociously drawn over his head, one of the old men sat on a stool. As each boy came from the cage, he stood in front of this old man and confessed everything he could remember having done in his youthful lifetime. By questioning the lad's parents and villagers, the old man already knew everything the lads could tell, so they had small chance of telling falsehoods or concealing the truth. One lad became sullen and refused to talk, so they brought another stool, covered its seat with the stinging ububu beans and made him sit on it! He stuck it for a time, though it must have been like sitting in fire, and then he admitted having once committed a theft, stealing a goat from an old woman in a neighbouring kraal. At dawn the next day the "pupils" faced another secret ordeal at the hands of their witchdoctors and medicine men before having passed the rigorous entrance exam., as it were, to the last term of this savage school training.

School Rules.

As in our schools, they now had to observe many strict regulations. For the first four days they were "gated," and not allowed to see or speak to any friends, while as a special rule they had to dish up their food in small honey barrels, instead of the usual hide plates which the Nandi use. Then for a whole month they were kept within bounds, while instruction in hunting and shooting was given them. Besides the classes in tribal lore and practical pursuits to which reference has already been made, the Nandi's education includes rigid rules of respect to parents, elders and chiefs. A boy may not sit down in his father's presence without being told to; he must not speak out of his turn; he must not spit or indulge in any unpleasant habit in public. When he marries strict rules govern courtesy to his wife, he also learns the strange savage etiquette of paying calls.

Strict rules of the clan must also be learned, and some are not too easy to carry out in the face of temptation. A Nandi boy of the Kipiegen clan, for instance, must never eat zebra meat, however hungry he is, though zebras are easy to hunt; he must never dig a hole in the ground, make hunting traps, or wear any animals' skins for clothing, except rock-rabbit, which are singularly difficult to catch! In one clan no boy is allowed to touch a donkey. In another, lads have the special privilege of choosing native judges to settle disputes; in another of finding springs and using spring-water. All these intricate laws the lads learn during a further three months in the forest school, after which they undergo another strange rite. A hut is built in the river, under the water, and every boy has to plunge into the torrent and crawl four times through the hut completely submerged. This "cleanses" the lads of all evil in the sight of *Asis*, the sungod. Another eight weeks of training, and the lads "pass out."

This is a proud day for them, for they go back to their parents' huts and each boy knocks at his father's door. His sister, if he has one, always opens it to him and then he greets, not his father, but his mother who proudly hands him his great seven-foot warrior's spear, a mighty buffalo-hide shield painted with the device of his clan, his sword in its scarlet hide scabbard, his warrior's earrings, and his hunting-club. Well may the wrinkled old Nandi woman, bowed down with the weight of her oxhide cloak and great brass wire bangles, be proud of her son. He is a man to whom fear, cowardice, sloth and deceit are unknown; a man who can now make his voice heard at the tribal councils, can command respect, and shoulder his share in the affairs of his people.

The young men are often fired to exhibit their prowess as warriors by "blooding" their spears, that is, by sallying off on a raiding expedition to kill the clansmen of some neighbouring enemy tribe and plunder their cattle. That, of course, is an exhibition of warrior zeal which British rule has to suppress, but it speaks of the fearlessness with which these lads, mere boys a few weeks previously, are endowed by their "school" training in the hands of their wise old men.

Britain's Task.

Stripped of its fantastic ritual and savagery there are points in this native method of making men out of boys from which we might learn; knowledge and respect for law, pride of race, and, not least, that strong bond of parental affection and respect so strikingly shewn when the old Nandi mother presents her son with the spear and shield which are the sign manual of his manhood. These are traits of savage life which Britain's new native administrative policies in East Africa aim to preserve. Her task, as the much debated Hilton Young Report outlines, is to make the savage into a good African by weaning him from the superstitions and witchcraft that mar his strange black civilization with brutality, while at the same time preserving and encouraging much of the fine social code which he has evolved in his grim struggle with Africa's fierce spirit.

The Progress of Colour Photography.

By T. Thorne Baker, F.Inst.P., F.R.P.S.

Wide curiosity about colour photography has been roused by the discovery of processes introduced to the public during the past summer. Mr. Thorne Baker here explains how the successful methods work.

PHOTOGRAPHY had hardly become a practical art before speculation began as to the possibility of recording things in their natural colours. Time has taught us to appreciate in monochrome or black and white the beauty of a photographic representation of a coloured subject. But those who can look back a few decades will remember what a sharp and disappointing contrast there once was between the gaily coloured little picture on the focussing screen and its sombre reproduction in the print.

The early speculations referred to had a curious result. Pioneers of the time devised and foresaw—even patented—practically every method of producing natural colour photographs that is in use to-day. New details of operation have, of course, been introduced, but the main principles were invented. The physicist did his work well in the direction of colour photography, but the chemistry of emulsions was in a state quite inadequate for the purpose, and plates of those days had neither speed nor colour-sensitiveness. It is the amazing progress made during the last few years in producing both speed and sensitiveness to colours in plates and films, together with the invention of new and elegant printing processes, which have raised the barrier, and we shall now see how the amateur photographer can take colour pictures with little or no special apparatus.

Two Classes.

Colour photography must here be divided into two very distinct classes. One of these involves reversing the negative taken in the camera, and converting it into a single positive transparency which can only be viewed by transmitted light. The other involves the taking of three negatives simultaneously, from which composite colour prints can be made on paper and in any number.

The first method has, of course, been available for many years. It was introduced as a practical proposition by the brothers Lumière, of Lyons, who brought out the famous Autochrome plate over twenty years ago. This plate remains substantially the same to-day, but it has recently been imitated in somewhat different form by the German firm Agfa, and it was also put out for a time in film form (as against glass plates) by the Lignose Company of Berlin.

So-called screen plates consist of a pan-chromatic, or fully colour-sensitive, emulsion coated upon glass which has been first provided with a *matrix*, or network of tiny squares or irregular shaped areas of the three primary colours. They are exposed with the glass side towards the lens of the camera, and all the rays forming the image have therefore to pass through the coloured matrix and be subjected to a *colour analysis* before they reach the sensitive emulsion.

The "Reversal" Process.

Rays of any colour which pass through the matrix and expose the emulsion form a patch of black reduced silver when the plate is developed. The process of "reversal" being to dissolve away the black silver image and leave transparent gelatine where it was, means that when the reversed plate is held up to the light we see these same coloured rays passing through the matrix in the particular patch. As the whole image is made up of thousands of such blue-violet, green and orange patches, it is seen as a whole, after reversal, in the original colours.

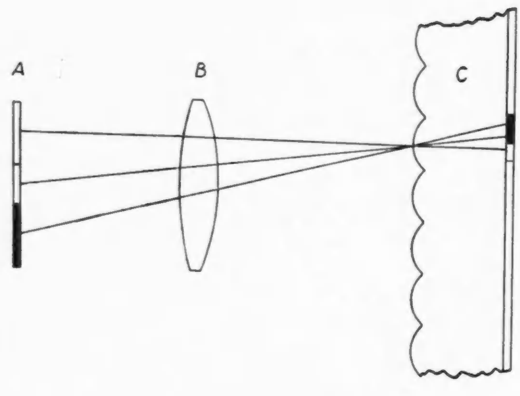
The light absorbed by the coloured matrix is considerable, and snapshot exposures are only possible in strong sunlight and with a lens of large aperture, such as F/2.9 or F/3.5. It may be mentioned in passing that the general tendency in cameras is to provide these large aperture lenses, which are being manufactured at far cheaper rates than heretofore, and as they are so very desirable for any form of colour photography their cheap production is very opportune.

Natural colour transparencies are easy to take, and perfectly simple to develop, reverse and redevelop. Green safe-lamps have been brought to such perfection during the past year or two that an amateur can work with quite a comfortable amount of light, and the "absolute darkness" bogey should be dropped once for all. The real drawbacks to these beautiful photographs are that they have to be looked at against the sky or in some suitable viewing apparatus, and they cannot be readily duplicated. Various methods

of copying them by projection and even by contact have been described, but even in expert hands the copies must be admitted to be disappointing.

In view of what has been said, the great public interest evinced in the colour snapshots process introduced this summer can be appreciated. Here, with a roll-film on the spool of which are wound three separate films, sensitive respectively to blue-violet, green and red, one can take with a single exposure three photographs which provide negatives recording the three primary colour sensations.

Three-colour photography, used on so enormous a scale as to-day in photo-mechanical reproduction, had no sooner become an accomplished thing than numerous trials were made to expose three plates simultaneously in the manner used in the colour snapshots process. A photographic emulsion absorbs only a proportion of the light thrown upon it by the lens—a great deal of the light passes through the plate. By placing therefore a second plate immediately behind the first a duplicate image will be obtained, and similarly, if the emulsions be translucent enough, yet a third plate may be exposed behind the first two.



THE KODACOLOR PROCESS.
Diagram—described in text—showing (A) colour filter, (B) the camera lens, (C) film with minute lens embossed on the surface.

Needless to say the relative speeds of the emulsions must be in equilibrium, the second being faster than the front one as it receives only a proportion of the incident light, the third being faster still. Also, if glass plates be used, the *separation* between the sensitive surfaces is considerable, and the two hindmost images will be badly blurred.

All early efforts at such " tri-packs " were fruitless, when these early experiments were made. But to-day it is possible to make emulsions of such great transparency, such excessive speed, and of such exceedingly pronounced *local* spectrum sensitiveness, that the tri-pack becomes possible. The advent of films, too, has eliminated the separation of the sensitive surfaces by the glass, so that three fairly distinct and well-balanced colour records can be made at one exposure, and that exposure a snapshot, given a good light.

How, then, is the three-colour print made from the negatives so obtained? Here a difficulty arises for the amateur, because trichromatic printing is both difficult and tedious, and the makers of the colour snapshot spool decided to " process " the exposed films, *i.e.*, develop and print them in properly equipped establishments. But materials are available, and literature is abundant, and any process such as imbibition, three-colour carbon or carbro, and so on, may be employed.

The making of a coloured print from three negatives can, for example, be carried out in the following way. Each negative is first printed by projection on to a glass lantern plate, *through* the glass. It is then developed and fixed, and after thorough washing it is immersed in a solution of copper sulphate, chromic acid and potassium bromide. This solution converts the image into silver bromide which can be removed by fixing, and deposits in its place a copper chromium salt that reacts with the gelatine and insolubilizes it in proportion to the density of the images. The result is that when the plate is washed in hot water a gelatine image remains in relief. The plate is now steeped in a solution of a suitable dye until saturated, well rinsed and squeegeed into contact with a piece of gelatinized paper. Here in a few minutes the dye image becomes transferred to the paper, and on separating the paper and the " printer " plate we find a photograph—in the colour used—on the paper support.

Suppose we have transferred by this method the blue image (printed from the red-sensation negative), we can next print, in register upon it, the yellow image (from the " blue " negative), and finally the pink image (from the " green " negative). In this way a composite print is obtained by the subtractive process of the original subject in natural colours.

An alternative method, invented by Dr. Martinez, is with prepared transparent printing-out materials composed of thin sheets of cellophane impregnated with the necessary chemical salts. These films print out in blue, yellow and pink and give coloured images of extraordinary accuracy. The three finished prints are transferred in register to a suitable support,

when they give beautiful natural colour photographs. In both processes tri-packs are used, the essential features of the roll-film tri-pack being, first, its high speed, and second, the fact that the red-sensitive film (which gives the *blue* print and therefore provides the definition) is placed outermost towards the lens. In the other process the blue-sensitive film faces the lens, and the definition is therefore not so good.

The Kodak Process.

Many readers of *Discovery* will have seen the delightful little natural colour pictures on the screen made by the Kodacolor process, and some description of this system will now be given. Although the double and triple printing in more or less primary colours is the basis of successful cinematograph processes such as Technicolor, these systems would be out of the question for amateur work ; and for the small home cine cameras taking sixteen millimetre or sub-standard film, resort has been taken to the earlier system of securing a coloured transparency built up of myriads of tiny coloured areas of the three primary colours.

The process introduced by the Kodak Company is unique in that the colours are obtained by purely optical means. A black and white negative is obtained and is reversed to a positive, also black and white. The only colour is in three primary sections of a light filter used over the lens of the camera in taking, and over the lens of the lantern in projecting.

A Frenchman, named Berthon, devised in 1908 a process for embossing cinematograph film with a number of microscopic lenses ; the embossed film is coated with panchromatic emulsion, and the colour filters are placed in the lens. This process, later worked out jointly by Berthon and Anthon Keller-Dorian, is the basis of the Kodacolor system, in which the film base, on the surface opposite that to be coated, is run between steel rollers which impress tiny cylindrical lenses along the length of the film. In front of the lens is a three-part filter consisting of strips of blue-violet, green and orange, the areas of which are so adjusted to match the colour-sensitiveness of the emulsion and give correct colour rendering. Just what happens will be seen at a glance from the accompanying illustration, which shows how the tiny lenticular rulings on the front of the film split up the light rays into filtered areas corresponding with those of the lens filter.

At any point of the image, therefore, there are silver deposits representing the colour analysis of that point, in microscopic form. The developed image is reversed, and when projected on the screen through a similar colour filter, the natural colours of the subject are reformed and the image is seen as a whole in natural colour. As Dr. Kenneth Mees writes in the Journal of the Franklin Institute, " the reverse of the fact that white light divides up into the colours of the spectrum is that light coming evenly out from the three colours of the filter on a projector and superimposed on a screen appears white. But cover up the blue and green segments of the filter (by silver image grains), and the screen will turn red. Cover up the red and blue, and the result will be green. Varying the areas of each colour through which the light may shine gives infinite shadings between these colours."

A most delightful cinematograph process in natural colours has been invented by Louis Dufay, in which a panchromatic emulsion is coated on a base on which is printed a matrix of some 750 coloured lines to the inch, green and red running in one direction and blue-violet running across these at right angles. The film can be used in any cinema camera without even a filter, and the pictures shown in an ordinary projector—for the actual colours form an integral part of the film. The results are exquisite, and Dufay's process will probably take a prominent part in the coming developments of colour cinematography. We must not neglect, however, the processes that are actually at work and giving a great deal of pleasure to picture audiences.

Two-colour Films.

Technicolor pictures are, for example, very beautiful, and are being shown at many theatres. Two negatives are made simultaneously in a camera provided with a prism which diverts half the light to a second film. A two-colour record of the subject is thus obtained. Prints are made from each negative by an ingenious dye toning process, and are cemented together giving a composite subtractive print. It is stated that by new developments of this process the benefit of the full three-colour process will be obtained.

The advantages of the Kodacolor process, and the new process of Dufay, are that colour cinematography is brought within the scope of the amateur photographer. The taking of coloured motion pictures is perfectly simple and certain, and thanks to the very remarkable progress made in the manufacture of colour-sensitive emulsions in recent years, these colour pictures can be taken at ordinary cinematograph speeds, that is, each little snapshot having only about one fortieth of a second's exposure. A new era in the history of photography has opened up, and those who have once made colour pictures successfully are not likely to be contented any more with black and white.

Book Reviews.

This Bondage. By COMMANDER BERNARD ACWORTH, D.S.O., R.N. (John Murray. 7*s.* 6*d.*).

When Commander Acworth first introduced his views about bird flight to the public in 1927, through the columns of *Discovery*, widespread interest was aroused. In place of the conception so long held by ornithologists as a class, and even by aviators, which endowed birds with a free-will and intelligence pictured by some writers as second only to that of man himself, it was suggested that all winged creatures were, in fact, the slaves of iron law. Observations made during many years at sea, and in particular when in charge of submarines, brought home to the Commander that every form of flying is a single-medium operation, consequently the smallest insect and the largest airship are subject to the same limiting factor. Thus it is that birds always alight head on to wind, and that their speed is governed by the prevailing current, whether this be favourable or in opposition to the direction of their flight.

The interesting reflections which this Law of Currents—as the author termed it—gives rise to in regard to bird migration, were the subject of articles in *Discovery* and of later controversy in these columns. The main argument is therefore familiar to readers, although the author's discoveries are of such importance to ornithology that the present more detailed exposition of his case should be read by every naturalist.

When, however, the author turns from the study of currents to other problems, he writes with less conviction, and it is to be regretted that his new idea has not been restricted to spheres where it is obviously of value. Remarks, for example, about Einstein's "shaky premises" show an obvious lack of perspective, and the fact that every flying object is subject to limitations, does not justify a prejudiced approach to aeronautical endeavour in general. No one suggests that flying has yet reached perfection, or that it will ever attain the same accuracy in regard to timetable as land locomotion. But it is already being undertaken on a strictly commercial scale, and in attacking the state-subsidized airways of Europe, the author should have studied the position in the United States. There several companies are already operating on a paying basis, and the journey, for example, of 260 miles from New York to Boston is flown in two hours at a cost of 33 dollars, as compared with five hours by rail for 12 dollars. The author's bitter attack on airships, moreover, must surely be modified by the successful world flight of the Graf Zeppelin.

A New Regional Geography of the World. By MARION I. NEWBIGGIN. (Christopher's. 5*s.*).

One of the chief merits of this book is that it accomplishes what it sets out to do. The purpose of modern geography is to bring out the relation between life and the physical conditions which prevail on the surface of the globe, so that a geographer should be able to answer two questions: First, "Where is it?" and, secondly, "Why is it there?" No geographer can fail to answer questions of the first type, but questions on the why and wherefore of a certain fact are less easy of solution. This book makes a valiant effort to answer them, and is thus distinctly modern in outlook, for such problems are now a prominent part of modern geography in strong contrast to the ideas of the subject in the last century, when the lengths of rivers and the populations of towns were considered worthy of remembrance.

Such, then, is the aim of the book. As the aim is high the method of attack is carefully thought out, and is essentially scientific and methodical. The land masses alone are considered and are dealt with in units which, though roughly comparable with the continents, are more susceptible of treatment than the continents themselves. Thus, Part I is occupied with "Europe and its Margins." With Europe are considered those parts of Africa and Asia lying along the Mediterranean, which are similar in many ways with the truly European northern shores of that sea. Five other parts of the book are devoted to Asia, Africa, North America, South America and Australia. In each the method of attack is similar. Thus Europe is divided into Western Europe and Eastern Europe, and the former into three "natural regions," the Western or Oceanic, the Central, and the Mediterranean. Whilst each division is discussed and its main characters ably brought out, it is in the consideration of the final units that the detail appears. Thus, France, which in itself is part of both the Oceanic and Mediterranean divisions of Europe, is finally considered as composed of seven natural regions, each of which is discussed. The accounts given are somewhat condensed, but the important features are never omitted. The same principle is applied, in somewhat less detail it is true, to the whole of the globe. An interesting feature of the book is a series of questions collected as an appendix, which are searching and to the point. The book is illustrated with many excellent photographs and numerous maps and diagrams. It can heartily be recommended to the higher forms in public or secondary schools and to beginners at a university.

J. E. HALLIDAY.

Life and Work in Prehistoric Times. By G. RENARD. (Kegan Paul. 12*s.* 6*d.* net).

This latest addition to the "History of Civilization Series" edited by C. K. Ogden is ably translated from the French, but it lacks the wealth of illustration so characteristic of English archaeological volumes. The introduction is excellent and forms a fitting prologue for the general reader before he comes to the chapters dealing with the various aspects of prehistoric life. The author divides prehistoric time into two periods, the earlier of which is universal, embracing all the world and all races from the first beginnings of humanity until the most civilized races learned to write. The second period, which he terms modern prehistory, is much shorter and is local in character, ending at different dates for different races. It is with the first of these that the book is primarily concerned.

From the introduction the reader gains a knowledge of the progress of the study of prehistoric life from the time the Roman philosophers alluded to the origin of civilization, through the days of the eighteenth century, when many writers surmised the origin of worked flints more or less correctly, and the nineteenth century, when the battle over their origin was fought and won by the advocates of human workmanship, until the present day, when ever extending systematic exploration has revealed the wonders of prehistoric art in the Pyrenian cave, Tuc d'Andobert, and other less spectacular treasures which are no less valuable to the prehistorian.

The problem of the food supply, the most fundamental for all races throughout the ages, is first dealt with; and this is succeeded by an account of fire and language, the two great discoveries which revolutionized early civilization. The first

industries, the dwelling place and clothing and weapons of defence are then described with comparative reference to customs observed amongst the most primitive races at present inhabiting the backward areas of the undeveloped continents. Man's relations with the animals, of which it is recorded only thirty-six species have ever been domesticated, the beginnings of agriculture and the first means of transport comprise three inter-related chapters, with the exception of the inclusion of water transport. Four chapters and a short conclusion, comprising a third of the volume, describe the relations between the peoples, the origin of the arts and the origin of science, and give an account of the first human societies much of which borders on the second period of prehistory as defined above. The public will find the book readable as well as instructive, yet it will also be of value to the student.

Harvard Lectures on The Vergilian Age. By Professor R. S. Conway, Litt.D., F.B.A. (Oxford University Press. 11*s.* 6*d.*).

This book has already found a place of honour in the libraries both of scholars and of a wider public; yet, though some months have passed since its publication, there may be some readers of *Discovery* for whom this review may still serve as a grace before the feast provided, and others will be glad to have their appreciation reflected in a journal which owes so much to Professor Conway. The work, as its title suggests, consists of a series of lectures recently delivered in Harvard University; but though the lectures deal with various topics and though in their original form most of them were written at different times and for different occasions, yet the author has been successful in creating a delightful volume which can be read as a single whole. The lectures are concerned with the life of about forty years (55-17 B.C.) "a period which, in spite of political vicissitudes, has a unity of its own, the true golden age of Roman literature." There is, however, a less superficial unity of which the reader cannot but be aware. It is due to that insight which Dr. Conway consistently shows when he is dealing with the period of his favourite poet, Vergil. Readers of his articles in *Discovery* do not need to be reminded of that insight. No living British scholar is so skilled in making the student and general reader feel the greatness of Livy and of Vergil; and while some critics might consider that his ardent enthusiasm sometimes causes him to overstate the certainty with which some conclusion may be drawn, no reader could possibly deny that his work is always stimulating, vigorous and alive.

The lectures might be regarded as a continuation of "New Studies of a Great Inheritance," but, as the author himself remarks, the purpose of this volume is somewhat different. It is "to identify the elements in the feeling of the time which shaped or coloured the thought of its great writers." Hence, most aptly, the book opens with an account of the Proscription of 43 B.C. The story of Vispullo, as told by Appian, and also the inscription erected by him (according to Mommsen's identification) in memory of his wife serve well to make clear to the general reader the atmosphere of that reign of terror and what it must have meant to Vergil and his contemporaries. Dr. Conway has always rightly insisted on the importance of interpreting Augustan literature by understanding those terrible memories of the period which followed the death of Julius Caesar. The second chapter—"Where was Vergil's Farm?"—is now mainly familiar, but its value is increased by excellent illustrations and appendices. Many authorities are convinced of the probability of the suggested site, but absolute proof is impossible; and there are still some conservatives who remain faithful to the Pietole tradition. If Dr. Conway were to conduct them in person round the whole district, even these sceptics might find it hard not to be converted!

Of the remaining chapters, perhaps the most generally interesting are those four which are directly devoted to the work of Vergil. Mention must first be made of the three other lectures in the book, which alternate happily with the Vergilian chapters. The first of these is a fuller treatment of an article which appeared in this journal, on a fragment of the *Fasti Consulares* found in 1925. Dr. Conway suggests many interesting topics which have a bearing on the period and on the restoration of the Regia, while the general reader is made to understand the importance of the *Fasti*. The two lectures which (each in an entirely different way) treat of the Second Punic War—both originally delivered at the Rylands Library, Manchester, but both considerably revised—seem at a casual glance but slightly connected with the general subject of this volume. The connexion, however, is to be found not merely in the fact that both of these chapters deal with Vergil's contemporary, Livy, but also in the deep impression which the Carthaginian War made upon all succeeding generations, and especially on the Augustan age. "What Vergil's contemporaries felt about the different aspects of that war was closely linked with their own experience." "Under Hannibal's Shadow" attempts a comparison between the problems faced by Rome and by Britain, each at the most critical moments of their histories. In this way Dr. Conway will help students to a more imaginative understanding of Livy's narrative. This is even more true in "The Portrait of a Roman Noble,"—a suggestive account of Livy's characterization of Scipio Africanus. A comparison between Livy and Polybius helps to bring forward the essential qualities of Livy's power, and there is a suggestion of the importance of the vigour of Scipio as embodying in Livy's mind the strength and weaknesses of the Republic. Some might wish that this chapter were longer or that in place of the long extracts of translation from Livy—delightful in a public lecture but less necessary in a book like this—we might have a more detailed study of Livy's methods.

We turn now to the four other chapters which deal directly with Vergil's poetry. It is in these lectures that we see Dr. Conway's qualities at their best. Chapter III is the slightest of the four, yet in a very small space we are given a sympathetic understanding of the ideas in Vergil's mind when he introduced the Golden Bough into the sixth book of the *Aeneid*, to be symbolic of human affection. The *Aeneid*, as Dr. Conway knows so well, is poetry, and to attempt to summarize in a sentence the points made in this lecture would make them appear prosaic; whereas, in fact, the lecture is full of deep poetical appreciation. In "An Unnoticed Aspect of Vergil's Personality" and in "The Philosophy of Vergil," the author treats of subjects which, one feels, he has very much at heart. But in the small space of two lectures, he could not do more than throw out suggestions of the conclusions which he has reached after devoted study. One cannot help wishing that it had been possible to give fuller treatment to these fascinating subjects. Yet in spite of the necessary brevity, Dr. Conway has managed to suggest a great many points. In one of the chapters he exemplifies Vergil's "characteristic shyness" and his power of sympathy, and he concludes the chapter with that interesting study of Vergil's deification of Augustus, the main arguments of which were included long ago in a paper read by him to the Classical Association. It is very pleasant to have the theme (on *Georgics* I 24-42) here set out in a most "readable" form, and it much enhances the general interest of the volume. The

other chapter—" The Philosophy of Vergil "—might well be read directly after " An Unnoticed Aspect," since it deals more deeply with one of the topics there put forward.

This chapter, I venture to think, is the most important in the book. Dr. Conway enumerates a number of cases exemplifying how Vergil " saw two sides to every human event." The point is illustrated delightfully from the *Georgics* and the *Aeneid*, and we are shown how the poet's " dualistic " habit of mind is a characteristic both of his style and of his thought. We see it in small details of expression and in the large conceptions which underly his work. No lover of Vergil can afford to ignore the suggestions made in this chapter. In the last lecture in the book—" The Architecture of the Epic "—there is an explanation of the construction of the *Aeneid*, and it is shown how the " governing power " of Book VI, placed in the centre as it is, unites " all that stands before it and all that stands after." Dr. Conway's suggestion about the alternate books of the *Aeneid* does not appear entirely convincing, but the argument is stimulating.

The whole book is filled with a rare sense of the value for the present day of the literature with which it deals. Scholarly lovers of Vergil and readers who know little of Latin will be united in feeling gratitude. They will be helped by this book to gain a deeper appreciation of that age which Dr. Conway calls " Vergilian," because its " governing conceptions are represented most clearly by Vergil."

S. K. Johnson.

The Rhythms of Life and other Essays in Science. By D. F. Fraser-Harris. (Routledge. 5*s*.).

The fact that several of the essays contained in this volume have already appeared in print does not detract from either the interest or value of this publication. Previous books in the " Science for You " series have established it as one which cannot be ignored by any who wish to keep abreast of the rapid advances in the various branches of science, and this latest addition maintains this same high standard. In all there are eighteen essays, including such diverse subjects as animal electricity, animal heat, suspended animation, the cause of colour and the nervous system. The modern as well as the mediaeval practice in such matters as the ventilation and heating of houses, the sanitary arrangements of towns and the methods of road making are all contrasted with the results of recent research into the manner these important problems were solved by the Romans almost two thousand years ago. One chapter deals with the popular superstition that women are more sensitive than men, which modern science, from the observations described, tends to disprove.

Wayside and Woodland Blossoms. Series III. By Edward Shep, F.L.S. (Frederick Warne. 7*s*. 6*d*.).

This volume completes the two earlier series already published, and is sure to prove as popular a guide to British wild flowers as its predecessors. The chief feature of this series is that it contains a complete record of all the wild orchids indigenous to these Islands, together with an account of some of the rarer as well as some of the more common wild flowers omitted from the first two series. Of special interest to the country rambler is the chapter entitled " What are orchids ? " and the inclusion of numerous photographs as well as coloured plates of many of the 153 species described in the text. A description of the family characters and a classified index to the natural orders, genera and species of plants described in the volume concludes a very useful book for the nature lover.

The Lives of Sir Joseph McBride. By Giles Dugdale. (Heffer. 5*s*.).

This satire on academic life will be enjoyed by a wider circle of readers than those associated with the older universities. The book takes the form of the autobiography of a famous archaeologist and college tutor, residing at the hybrid University of Cambletchford, but not until some years afterwards does the true story of his career leak out through the indiscretion of a valet. It is then that the manuscript comes into the hands of its brilliant young author, Mr. Giles Dugdale, who contributes some clever sketches to his book. There are other illustrations by Marie Vassilieff and William Walcot, which in view of the author's own artistic attainments are superfluous but none the less entertaining.

To reveal the ramifications of the plot would be to spoil the fun of potential readers, but it must be explained that behind it all is a truth which not even playful fantasy can altogether conceal. That the don too often acquires a reputation out of all proportion to his merit is a fact which does not yet belong entirely to the past. No one wants the cloistered attitude to disappear altogether, particularly in times of growing materialism, but it is all to the good that our academic leaders should get more into touch with mundane affairs.

However that may be, to end on a solemn note is out of keeping with this book. As the delightful but imaginary American Professor of Comparative Biography says in his preface : " It is almost inevitable that doubt should exist in certain prejudiced quarters as to the authenticity of Mr. Dugdale's discovery, but about one thing all will agree. Whether the book be regarded as the autobiography of a great American adventurer or as the novel of a great British archaeologist, it must surely rank as the most valuable contribution to McBridinia in recent years." All the same, we are told that the author of the *official* life, Dean Buckram, thinks the book is " a matter for the Home Secretary," while the valet—not forgetting to add another indiscretion, that he has " received with thanks " the author's cheque—guarantees his story to be nothing but the truth !

The Roman Eagles. By H. C. Bailey. (Gill & Sons. 1*s*. 6*d*.).

This little book is a story about a boy and girl, written for young readers. Though there is so wide a gulf of time between us and the people of England before it came under the Roman rule, something useful may be learnt by the young citizens of 1929 from an action picture of life when the British people were " cut off from the whole world " and making a wayward struggle against the civilizing power of an Empire. To this end the book may be highly recommended.

As Mr. Salter Davies points out in his Foreword, the history-teacher, nowadays, does his best to rescue his subject from formalism. Story is History's ally. The story-teller who knows his business places his characters in scenes which the child himself knows. History, like charity, begins at home. There is no county in England which has not its fund of material for stories. The tale of the first Roman invasions must rouse the interest of any child ; but, to the child of Kent who has walked the street of Durovernum or has scrambled below the cliffs of Dubris, these things appeal with a special intimacy.

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